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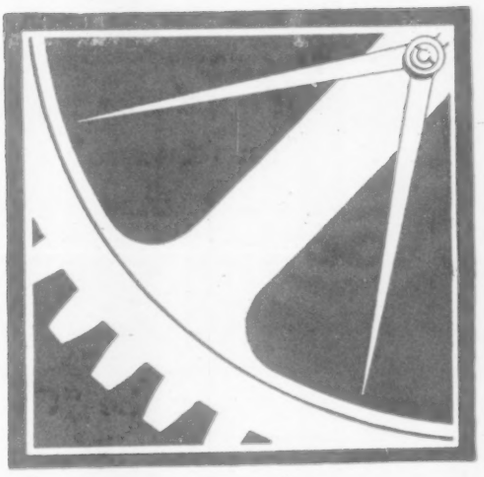
MACHINE DESIGN



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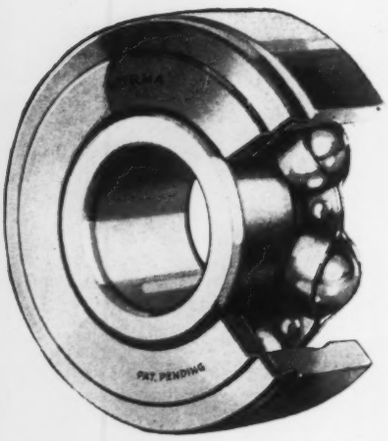

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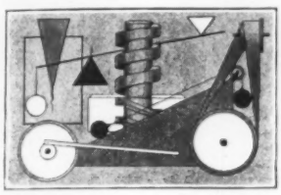
Volume 2 **August, 1930** **Number 8**



A New INDEX

EVERY page—every item— in MACHINE DESIGN *is intended definitely to be of service to its readers; to assist in solving problems in design or to be of genuine reader interest. Included in this are advertising pages.*

Design information dominates. Paragraphs on specific design features occur in every major article. But how to find items related to your problems—how to locate specific data at a glance?

We believe our latest departure from orthodox publishing standards—the itemized index on page 7 —provides the answer. Comments will be greatly appreciated.

L. E. Jermy.

Managing Editor

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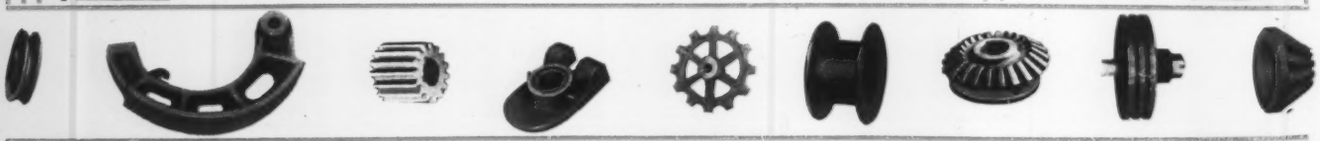

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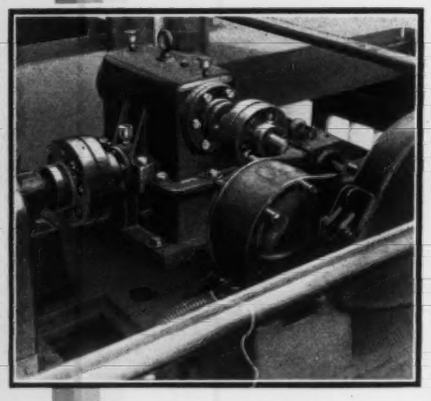
FOR those of our subscribers who keep a permanent file of Machine Design, a combined contents index, covering the twelve issues of the year is available each January for the asking. If you want a copy for your files, just notify the circulation department now to put your name on the list to receive one each year as it is published.

This year, in addition to the regular index, the issues of Machine Design from August to December will be covered by an Itemized Index combined for these months. This should prove of unusual value for reference purposes.

In this connection, you still can get a copy of the 1929 Contents Index if you'd like it.



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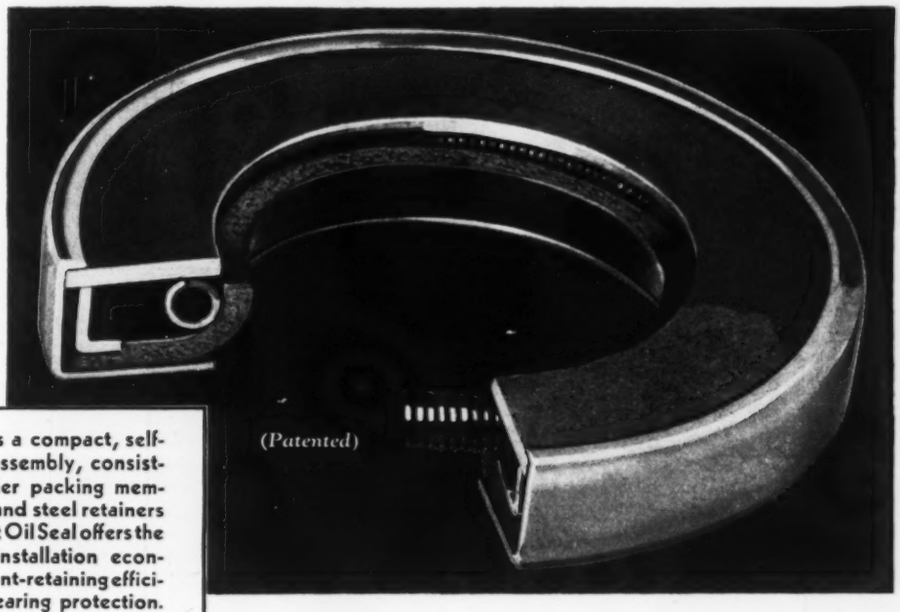

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Calendar of Meetings and Expositions

Aug. 24-29—International Congress for Applied Mechanics. The third congress to be sponsored by this organization will be held at Stockholm, Sweden. On the evening of the first day an informal reception-ceremony will be held at the Academy of Engineering Sciences and sessions will be carried out in the Royal Technical university, beginning the following day. German, English, French and Italian languages will be used. At the first session hydrodynamics and aerodynamics covering the theory of propulsion and the problem of resistance will be discussed. The second session will embrace the theory of elasticity and strength of materials including stability and strength of thin-walled constructions, limit of rupture and theory of plasticity, while the third-session will bear on rational mechanics and problems of oscillations. Correspondence should be addressed to Prof. W. Weibull, general secretary Third International Congress for Applied Mechanics, Klg. Tekniska Hogskolan, Valhallavagen, Stockholm, Sweden.

Aug. 26-28—Society of Automotive Engineers, Aeronautic meeting to be held in conjunction with National Air Races at Chicago.

Aug. 31-Sept. 7—International Congress for General Mechanics. Meeting in Liege, Belgium. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

Sept. 8-13—National Association of Power Engineers. Annual convention and exhibition of power machinery at Cleveland Auditorium, Cleveland. Fred W. Raven, 417 South Dearborn street, Chicago, is secretary of the association.

Sept. 22-26—American Welding Society. Annual fall meeting to be held at Congress hotel, Chicago. W. M. Spraragen, 29 West Thirty-ninth street, New York, is technical secretary of the society.

Sept. 22-26—American Society for Steel Treating. Annual meeting to be held in connection with the National Metal exposition at Stevens hotel, Chicago. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary of the society.

Sept. 22-26—American Institute of Mining and Metallurgical Engineers. Annual fall meeting of the institute of metals division at Stevens hotel, Chicago. W. M. Corse, 29 West Thirty-ninth street, New York, is secretary of the institute.

Sept. 22-26—American Society of Mechanical Engineers. Annual fall meeting of iron and steel and machine shop practice divisions to be held at Stevens hotel, Chicago. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

Sept. 22-26—National Metal Exposition. The twelfth annual congress and exposition sponsored by five national technical societies will be held at Stevens hotel, Chicago. Technical sessions, the annual meeting of the American Society for Steel Treating, and other features of the congress all will be held in the hotel. The 1930 show will cover approximately 75,000 square feet of floor space. Heavy displays and machinery will occupy the exhibition hall and foyer on the first floor and the second floor exhibits will be located in the grand ball room and its foyer, and in the lounge, writing room, and main dining room of the hotel. W. H. Eisenman, secretary of the American Society for Steel Treating, is director of the exposition.

Sept. 29-Oct. 1—American Gear Manufacturers association. Fall meeting to be held at Hotel Clifton, Niagara Falls, Ontario, T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary of the society.

Sept. 29-Oct. 3—National Safety Council. Nineteenth annual meeting to be held at Fort Pitt and William Penn hotels, Pittsburgh. Metals section meetings will be held Tuesday and Wednesday mornings and Thursday afternoon.

Oct. 7-10—American Road Builders' association. Sixth international road congress Washington auditorium, Washington. An exhibition of the best products of the American highway machinery manufacturers will be held simultaneously with the congress. Delegates from 56 countries will study the exhibits to acquaint themselves with the trends in design of equipment built in this country.

Oct. 8.—Gray Iron institute. Third annual convention to be held at Hotel Cleveland, Cleveland. Arthur J. Tuscany is manager of the organization.

Oct. 8-10—National Association of Farm Equipment Manufacturers. Annual convention to be held at Congress hotel, Chicago. H. J. Sameit is secretary of the association.

Oct. 20-25—National Electrical Manufacturers' association. Annual meeting to be held at the Chamberlain-Vanderbilt hotel, Old Point Comfort, Va.

Oct. 20-25—Dairy and Ice Cream Machinery and Supplies association. Annual exposition in Cleveland. Roberts Everett, 225 West Thirty-fourth street, New York, is secretary.

MACHINE DESIGN
August 1930

Applying Hydraulic Principle in Loaders and Conveyors

By John Merck

IN the last few years the hydraulic method of operation has become increasingly popular in design of machines, this method providing extreme flexibility in control, simplicity in design and a possible reduction in cost compared with mechanical methods of operation.

The principle not only has been applied to production machinery but its use has extended to the field of loading and conveying machines. A striking example of what has been accomplished on this class of equipment may be found in the design of the mechanical loader built by the Joy Mfg. Co., Franklin, Pa. Caterpillar mounting as may be seen in Figs. 2, and 4, is employed for this machine. It is driven by a 35 horsepower motor and has two forward and reversing speeds. Many interesting features are incorporated apart from hydraulic operation of the various machine units, chief among which is the patented gathering arm mechanism. General features of the three main units of the machine—the chassis, front conveyor and swinging rear conveyor—will be taken up in turn, finishing with a discussion of the hydraulic operation.

General Features of Machine Chassis

A horizontally split gear case, containing a two-speed forward and reverse transmission for propelling the machine, forms the chassis rear end. Another gear case, containing transmission for driving the front conveyor and gathering mechanism forms the front. The motor is placed between the two transmissions with axis lengthwise, driving from both ends of armature shaft. Cast steel side frames connect the trans-

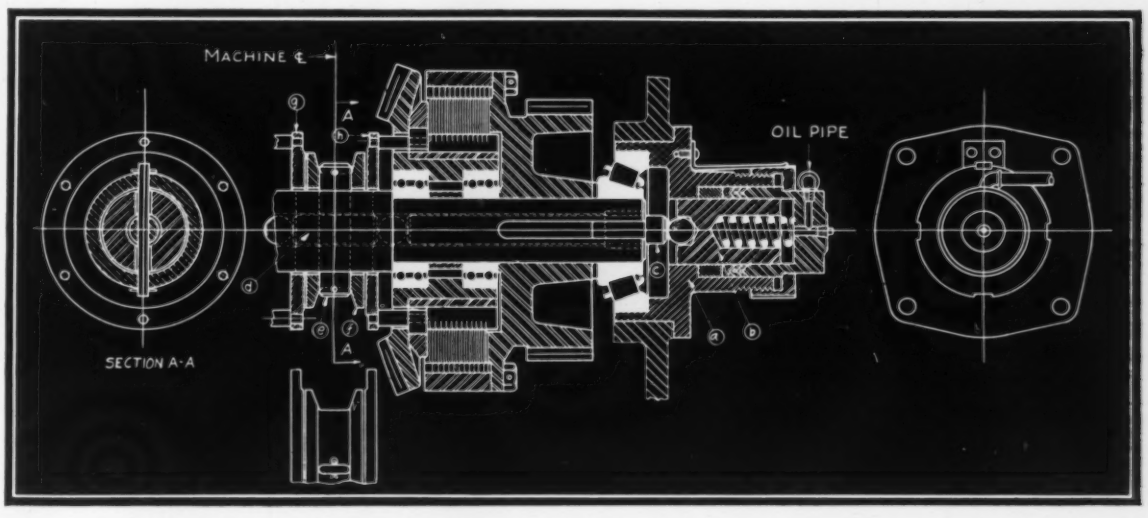


Fig. 1—Clutch mechanism showing how hydraulic pressure operates forward and reverse clutches through rods in center of shaft

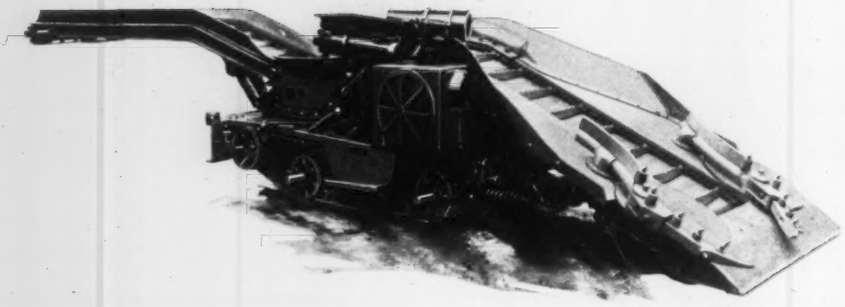


Fig. 2—Machine consists of three main units, the front conveyor, chassis and swinging rear conveyor

mission cases and support the motor.

Forward and reverse motion is obtained through two bevel gears revolving in opposite directions by meshing with the same bevel pinion. The two bevel gears drive through multiple friction disk clutches, two spur gears meshing with gears on high and low unit. A sliding spur pinion between the two high and low gears can engage either one of the two, by jaws cut in end of hubs, and at the same time mesh differential ring gear on differential unit. By engaging sliding pinion with high or low speed gear, high or low forward and reverse crawling, speed is obtained. A bevel gear differential drives the caterpillar through drive sprockets mounted on differential shaft.

Brake drums keyed to the hubs of the caterpillar drive sprockets serve as steering mechanisms, as the differential makes possible the retardation of one side by means of the brake while the other side is speeded up. This theoretically is not perfect, as it throws a strain on the differentials, but it has been used successfully for years on this type of machine.

Coupling Eliminates Vibration, Wear

The motor is connected to this transmission by a flexible coupling driving through a spur gear reduction to the forward and reverse unit. Before the advent of the coupling design, the motor pinion was on the free end of motor shaft. This was not a successful mounting, and considerable trouble was encountered from excessive vibration, wearing of pinions and bad commutation; the vibration causing brushes to chatter with consequent sparking and pitting of commutator. The trouble was found to arise from slight deflections of the chassis frame when the machine crawled over uneven ground and threw the drive out of line. Introduction of the coupling drive eliminated this entirely.

Considerable difficulty was encountered in the design of an effective seal around the armature shaft where it enters the gear cases. Both ends of armature shaft originally were extended into the gear compartments and oil splashed up by the motor gears in these compartments found its way through the single felt packing seals.

It therefore was decided to extend the motor end caps into the gear housings and provide a seal between the end caps and the housing wall. The extended portion of the end caps was turned to fit bore in housing. Ordinary felt rings were used with good results and this stopped the oil leak to the outside. However, by extending the end caps into the gear compartments, another and more serious problem developed. The oil now would flow between the armature shaft and the motor end cap bore and flood the motor bearings, thinning the heavier lubricant in this compartment, and finally finding its way into the motor with the well-known and dangerous results. A seal consisting of several packing rings fitted into end cap bore was tried with little success. The seal held the oil for a short time until it became worn or burned due to the high speed of the shaft, and oil still found entrance into the motor.

Finally the spiral groove type of seal was developed, the grooves being cut in a long bronze sleeve pressed on armature shaft between motor pinion and motor bearing and having a close running clearance in the end cap bore. The spiral groove extends from the pinion end of sleeve for two-thirds of its length. The remaining part of the sleeve is made larger in diameter and carries three annular V-shaped grooves as seal for the motor bearings. On the bottom

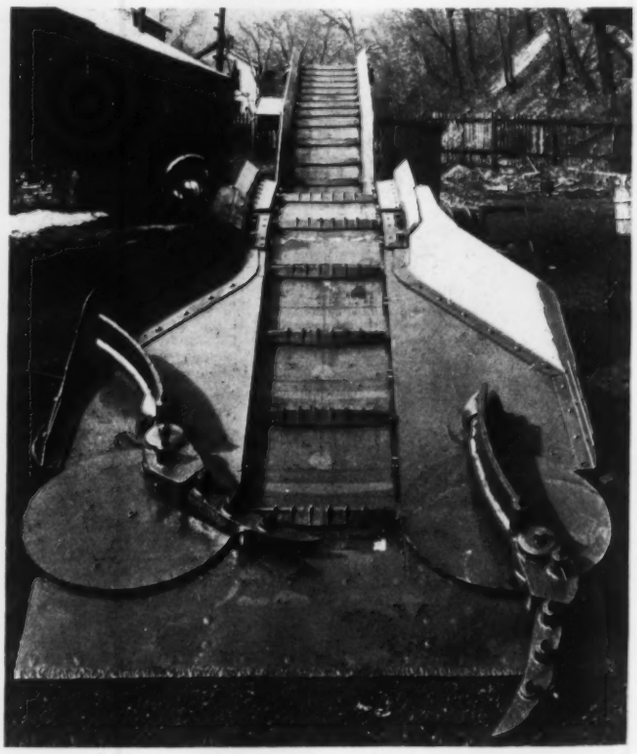


Fig. 3—Gathering arms are mounted on rotating discs as shown and operate alternately

of the bearing cap between motor and gear case an opening is provided which serves as a drain in case motor is reversed. This, however, is rarely done as it would tend to pump oil out of the gear case.

Front Unit May be Raised or Lowered

The front conveyor seen in Fig. 3 is of the scraper type and is hinged between two pedestals on front transmission case. A fixed extension of front conveyor extends back over chassis for discharging into the rear conveyor.

The whole front conveyor unit with gathering head resting on the ground in loading position, has an inclination of 25 degrees and can be raised and lowered by means of a single hydraulic jack to compensate for unevenness in the mine floor or ground on which machine is working. The gathering mechanism has two gear cases bolted onto the front conveyor frame, each containing a bevel gear drive.

A revolving disk is mounted through the center of each case with its bottom side clearing the top of the gathering head deck plate. This disk is revolved by a bevel ring gear bolted to the lower side of the disk. A circular ring, cast on the bottom of the disk, fits around the outside circular top of gear case, providing a dust and oil tight seal. The disks carry on their upper sides, at 10¼-inch radius, a pin around which the gathering arms are pivoted. These arms are curved on one end and carry a socket on the other into which fit the replaceable gathering fingers for moving the material onto the gathering head and into the conveyor. The curved end of the arms slide in a swivel block mounted in the frame a short distance from edges of disks.

The orbital path of gathering arms is controlled by the curved bar, and can be modified by changing the curvature of the bar or location of its swivel point. Each arm moves, or gathers, alternately at about 38 strokes per minute. This speed can be varied and is, of course, controlled by the character of the material to be loaded, and the capacity of conveyor. The shape of the gathering arms also should change with the different types of material to be handled.

The rear conveyor is mounted on top of differential unit and consists of a hopper containing the driving mechanism and a conveyor. The conveyor is hinged to the hopper and is adjustable vertically by a hydraulic jack supported on a bracket bolted to the hopper.

Hopper is pivoted in center, as shown in Fig. 5, and is supported by two adjustable rollers running on a circular track on top of transmission case, enabling the rear conveyor to swing 90 degrees to either side of center line. Rollers are spaced 30 degrees off center and at a radius of 15 inches from hopper pivot point.

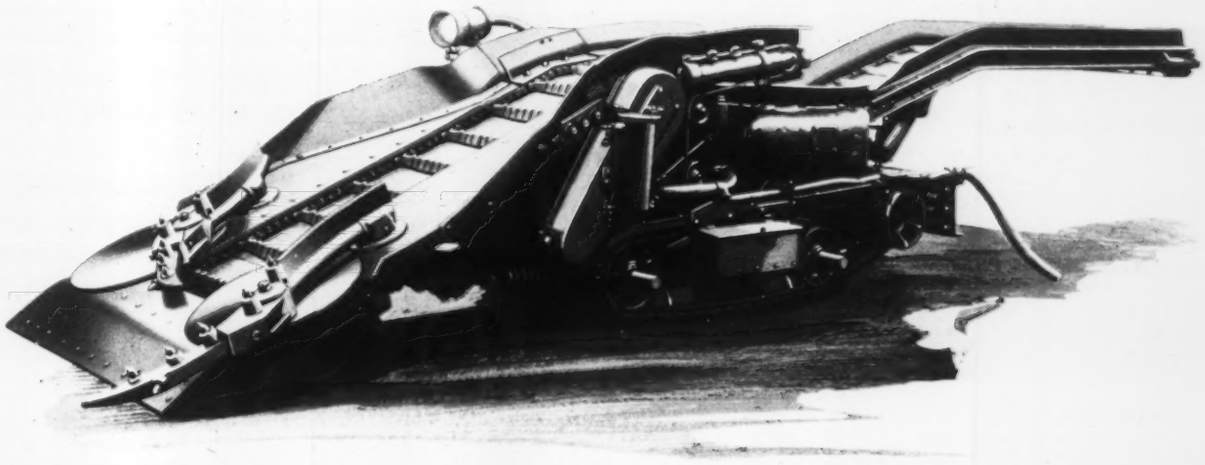


Fig. 4—Caterpillar mounting is employed to facilitate operation on uneven ground

Swinging of rear conveyor is accomplished with two cables actuated by two hydraulic jacks, mounted one on each side, along the sides of front discharge conveyor. One end of pistons in these jacks is forked, and carries a small rope sheave. A cable anchored in the top of cylinder head leads back over the piston sheave and is returned over a sheave located below the cylinder head, down over a third sheave. It then leads back to an 18-inch diameter rope groove cut in the bottom of the hopper. Cables are taken in through a hole in the hopper bottom and anchored in the hopper wall.

Applied Pressure Swings Rear Conveyor

By applying pressure to right hand jack first, forcing piston out and consequently exerting a pull in the cable, the rear conveyor is swung to the right. At the same time a pull is exerted on rope on left side of hopper, forcing piston into cylinder and automatically forcing the oil out. The opening and closing of valves for these cylinders is done through main control valve.

The forward and reverse clutch, Fig. 1, due

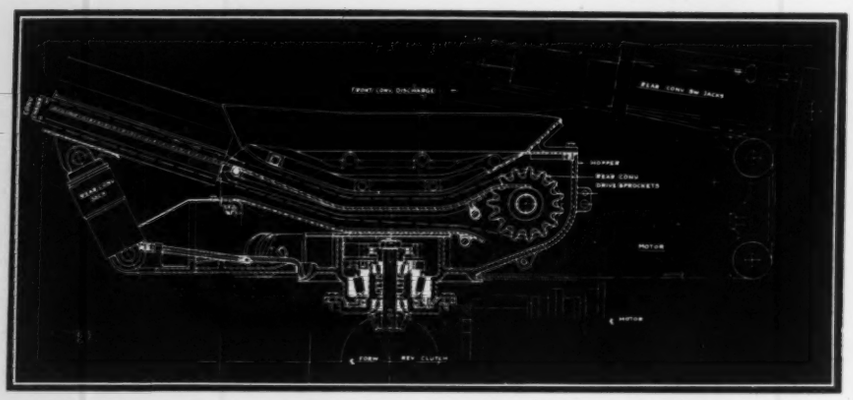


Fig. 5—Hopper in center of machine. Rear conveyor cylinder jack is shown at left and outline of front conveyor at right

to its location, the amount of power to be transmitted and its reversible feature, presented a difficult design problem.

Being enclosed in an oil tight case within an extremely cramped space, the only possible way to actuate the clutches was through the center of clutch shaft to the outside. The clutches originally were designed with a mechanical operating mechanism which was not entirely successful. This was due, to a certain extent, to the fact that the clutches were of lower capacity and an extremely high unit pressure on clutch disks was required which in turn taxed the operating mechanism in equal ratio.

Hydraulic operating mechanism then was adopted, this having an additional advantage in the convenience by which it could be applied to this particular case, since other operations also were performed hydraulically. The application proved to be satisfactory and was maintained even after it was found advisable to increase the capacity of the clutches.

Tapered roller bearings are used for mounting the clutch unit. The cup carriers shown in Fig. 1 at *a* are made into cylinders 2 inches in diameter, fitted with stuffing boxes and packing seals. In these cylinders is fitted a piston *b* which has in the center of the inward end a ⅞-inch diameter steel ball in-set deep enough in a drilled hole to roll edge over thus holding ball in place while leaving it free to rotate. A coiled spring fits in the other end of the piston between it and the cylinder head.

The ball in the piston contacts the end of a ⅞-inch diameter rod *c* projecting through the center of the hollow clutch shaft, and having a loose sliding fit in it. A similar ball is placed at the other end of the rod and in turn this ball is held against a short rod *d* in the center unit. Through this rod is fitted a flat key *e* extending through a slot in the shaft and with ends extending into a flanged collar *f* sliding on the shaft between clutch bevel gears.

Flat key *e* has a tight fit in rod *d* and collar *f* but has clearance in the shaft slot allowing the rod and the collar to slide axially and engage pin plates *g* and *h* which in turn engage the clutches. With clutches disengaged as shown in Fig. 1, i. e., with collar *f* in neutral position, a slight clearance is maintained between the sides of the collar and the clutch pin plates.

To operate the clutch, oil under pressure is let into the cylinder on one side, forcing the piston inward. This in turn actuates sliding collar *f* through key *e*, push rods *c* and *d*, and the balls, thus engaging clutch. At the same time, through push rod and balls, piston on opposite side is forced outward, compressing the spring and forcing the oil out of the cylinder. When the oil pressure is released the compressed spring forces collar *f* over to its neutral position. To operate the other clutch, the cycle is reversed. The control of the oil flow to these clutches will be dealt with later.

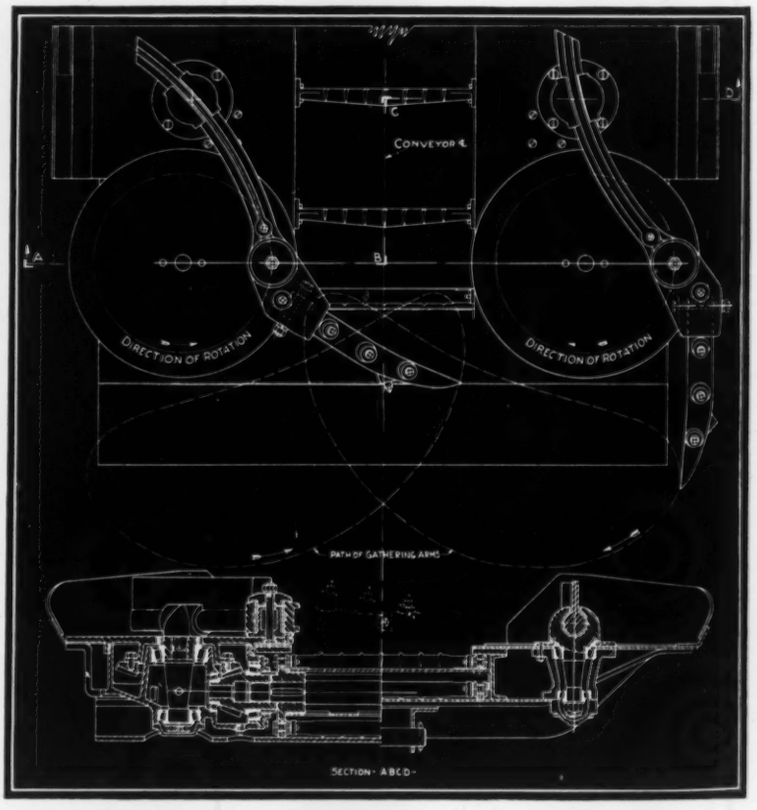


Fig. 6—Elevation and section of gathering arm mechanism. Note wide sweep of arms and manner in which this unusual movement is effected

No provision has been made to separate the clutch disks, i. e., retract pin plates, but this never has caused any trouble. When engaging and slipping the clutches, a sliding will occur between collar *f* and pin plates *g* and *h* since sliding collar always turns with the shaft. However, no excessive wear has developed.

The clutch push rods originally were made from oil hardened steel with a hardness equal to that of the steel ball which is of the type used in high grade ball bearings. A slight impression was made in the end of the rod by spinning the rod against a steel ball of same size as the one used. Ends were then hardened and polished. This arrangement did not work satisfactorily for any length of time. Flat spots developed on balls and ends of rods soon were damaged. This was thought to be due to the dent in the end of the rod not being centered accurately on the ball. Push rods made with perfectly straight ends therefore were tried. Regular drill rod was used with ends stellited and ground. The straight ends of the rods gave the balls a chance to find their own seats and run on center, and this arrangement proved entirely satisfactory.

Operations such as raising and lowering front and rear conveyors could be accomplished better by hydraulic jacks than with a mechanical drive. Swinging of the rear conveyor on the other hand presented a more difficult problem.

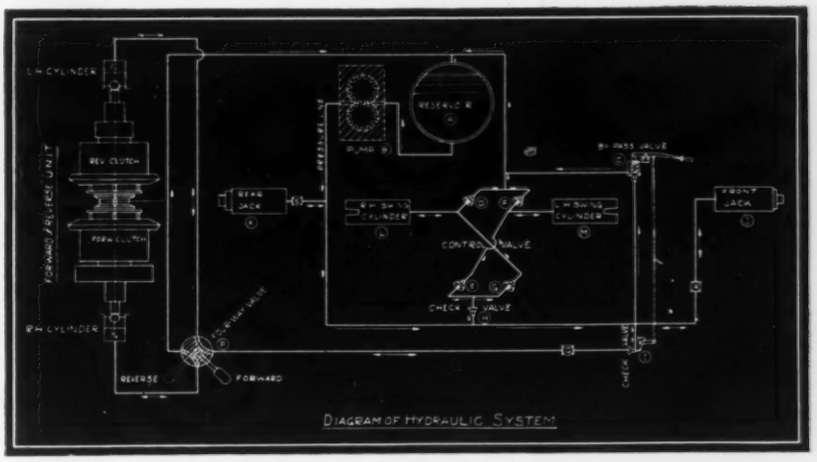


Fig. 7—Layout of the hydraulic system employed

However, hydraulic operation proved to be the better and simpler method of the two, especially since front and rear conveyor both could be operated in this manner.

Five Gallons Oil Flow per Minute

The hydraulic equipment shown on diagram in Fig. 7 consists of an oil reservoir *A*, a positive driven gear pump *B*, a hydraulic control valve in which valves *C*, *D*, *E*, *F*, *G*, *H*, and *I* are mounted, operating cylinders *J*, *K*, *L*, *M*, *N*, and *O*, the forward and reserve valve *P* and globe valves *Q*, *R* and *S*. When motor is started, the pump delivers a steady flow of oil, approximately five gallons per minute, from the oil reservoir to the control valve, and under idling condition the oil will pass through the by-pass valve *C*, Fig. 7, and back to the oil reservoir *A* under low pressure, approximately 20 pounds per square inch.

By lifting control lever, the by-pass valve *C* is closed, and the pressure in the pump discharge line is increased to normal working pressure, approximately 1000 pounds per square inch. This can be regulated by setting the relief spring in by-pass valve. The same control lever, through a rocker arrangement, operates valves *D*, *E*, *F*, and *G*.

Hydraulic cylinders used were first made of cast iron with bores smoothly finished either by reaming or honing; pistons were equipped with double cup leathers. However, this has been changed to an improved design of cylinder made of cold drawn steel tubing with end caps and stuffing boxes welded on. Malleable iron pistons ground smooth on outside diameter and fitted with special V-shaped packing and bronze packing glands also are used.

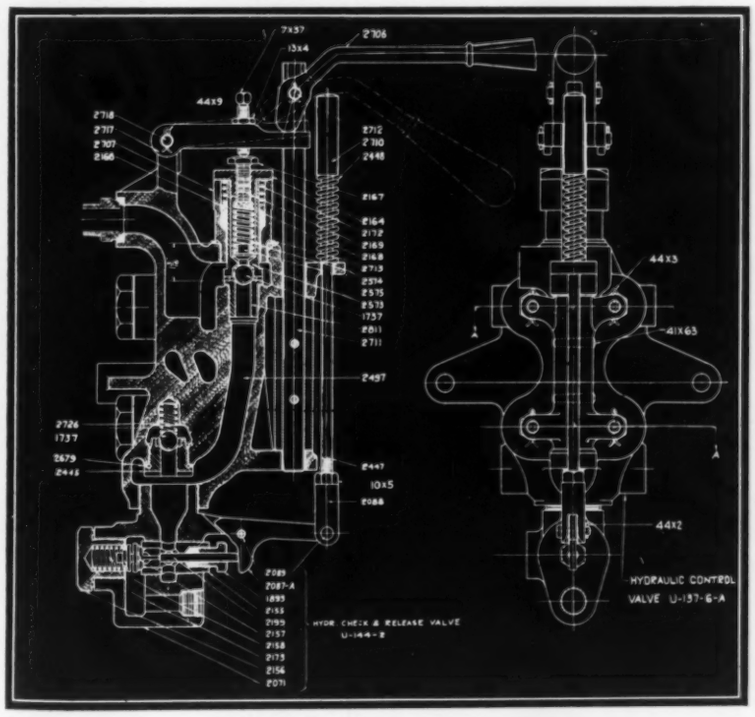


Fig. 8—Hydraulic control valve for operating the various units of the machine

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

COLOR in machinery thus far has been looked upon chiefly as a means for brightening up the product and adding a pleasing appearance. But that there are other advantages in the use of color rapidly is being recognized.

At least one manufacturing company recently has adopted a scheme for employing color for the purpose of making dirt detection easier. In the production of its electric motors, Reliance Electric & Engineering Co., Cleveland, is enamelling direct current motor windings a bright orange color. On these windings, maintenance men will be able to detect trouble-making dirt at a glance.

In the field of non-metallic materials, micarta long has been known as a product from which gears may be produced and employed with advantage from the aspect of smooth and quiet operation. Emphasis now is brought to bear, however, on the fact that this material has many other potential applications; it is being used, for instance, in the manufacture of propeller blades. The Southern Cross, which recently completed a round-the-world flight, was equipped with micarta-bladed propellers.

The base of the material is canvas, layers of which are impregnated with certain secret chemical components and compressed into a hard, moisture-proof substance as a result of the tremendous pressure exerted in the molding. Waterproof, non-metallic and strength characteristics afford the material many possibilities in design.

Moves Fourteen Tons Smoothly

Methods for setting in motion heavy reciprocating parts of machinery, without vibration or excessive stresses, require carefully studied design. Particularly so where the slide or other part is not allowed time for pick-up but must operate instantaneously at its working speed.

An example of the manner in which this is accomplished is found in a giant upsetter built by the Ajax Mfg. Co., Cleveland, and claimed to be the largest upsetting forging machine yet built, the leader slide of the machine alone weighing several tons.

A patented rocker type drop lock, shown in accompanying drawings, is the mechanism which sets this huge slide and a number of other working parts in motion. In Fig. 1 the lock is in the operating position engaged with the rocker, pitman and crankshaft. The chief feature of the device lies in the fact that the rocker engages the drop lock at its extreme back swing where the velocity is zero as the crankshaft

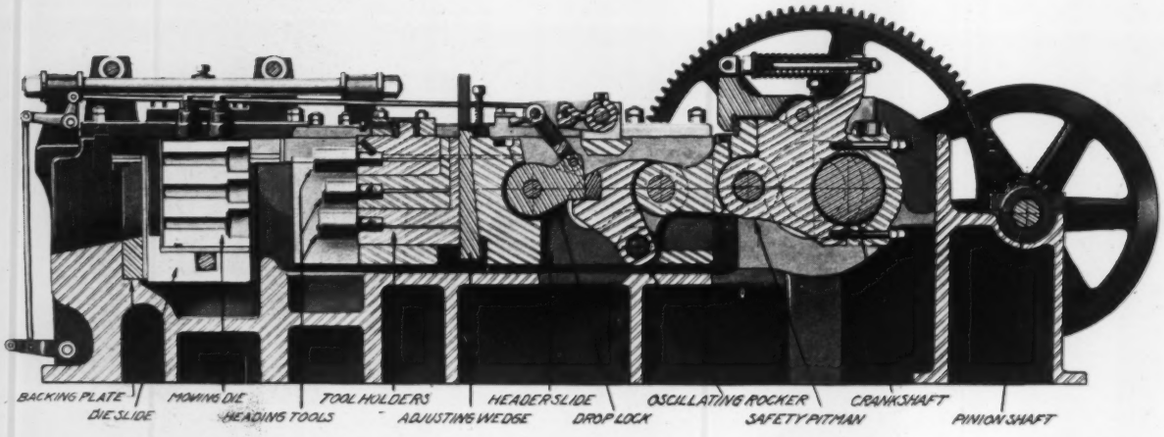


Fig. 1—Sectional view of upsetting machine showing, in center, patented drop lock feature. Engagement with header slide is effected at back dead center, insuring smooth operation

passes over back dead center. The slide consequently is picked up from rest with no more shock than if it were reciprocating continuously.

When in the disengaged position, as in Fig. 2, the lock is raised by means of a foot pedal controlled by the operator. This allows the rocker to oscillate around the shaft in the header slide upon which it is mounted. The crankshaft, safety pitman and oscillating rocker all are in continuous motion when the machine is idling with the lock in this position. Thus the energy stored up in the flywheel can be turned into actual work immediately. The drop lock is engaged at the back dead center position of the crankshaft.

Weed Cutter Installed on Boat

NECESSITY for mowing a heavy growth of pond lilies from a fifty-acre reservoir resulted in the ingenious boat mower shown in

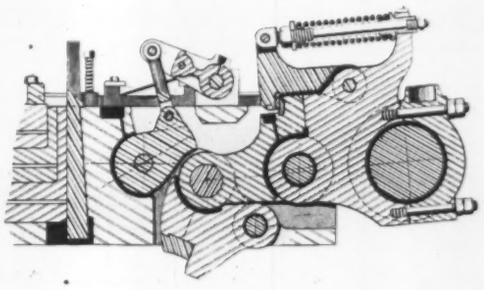


Fig. 2—Enlarged view of drop lock

Fig. 3.

This flat-bottom scow is driven by a 35 horsepower Universal marine engine which operates the cutting mechanism as well as propelling the boat. The mower is geared to the motor, the flywheel of the engine being removed and replaced by a spur gear. Between the mower and motor a clutch and transmission unit are employed so that the boat can be propelled when desired without the action of the cutter.

Adjustment is provided for the cutter bar as shown, to permit operation in different depths of water. The middle bar on the carriage acts as the driving shaft, this being rotated through a bevel gear. At the bottom of the shaft is an eccentric and connecting rod arrangement which gives the necessary oscillating motion.

Provides Reserve Production Facilities

A MACHINE developed recently for rolling heavy metal forms, by Dienelt & Eisenhardt Co., Philadelphia, incorporates a number of ideas worthy of the attention of engineers responsible for design.

Heretofore machines for forming heavy sheet metal into window framing, cornice molding, door butts and the like, have been of the "brake" type, operating on the principle of a press. Roll machines have been used only for

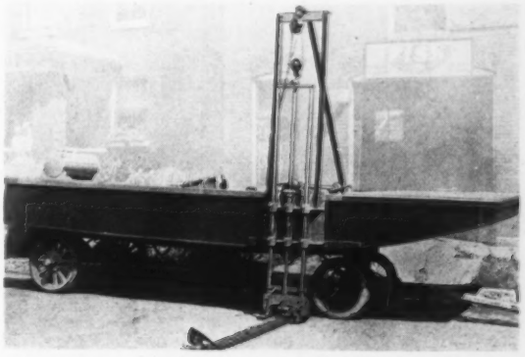


Fig. 3—Weed cutting mechanism attached to boat side for lake operation

comparatively narrow strips of light metal, as in making furniture hardware and similar articles. This particular machine, however, has been designed to roll 10 gage material up to 36 inches width.

The machine consists of twelve pairs of horizontal rolls, between which the strips of metal pass. These rolls are so shaped that the metal is molded progressively into its final shape, the impressions becoming sharper and deeper as the material passes through the machine, thus permitting sharp angles without breaking at the bends, which might occur if the material were formed too much by a single set of rolls. All operations are mechanical, beginning with the flat material and ending with the finished product, no intermediate rehandling and readjusting being required between the impressions.

The speed of travel is approximately 65 feet per minute while the machine occupies a floor space of only 22 ft. 6 in. by 8 ft. 4 in., or of 22

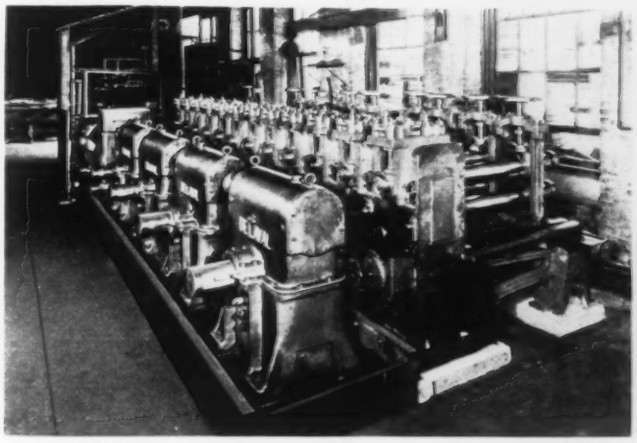


Fig. 4—Worm wheel shafts extend on both sides of reduction units as provision for increased production facilities

ft. 6 in. by 13 ft. 4 in. in a duplex machine of double capacity, so that great economy in time, labor and floor space is realized as compared with former practice.

To prevent wide and heavy material from rising and buckling between the rolls, the forming rolls are set close together, the horizontal center distances being only 16 inches. In handling heavy gage material narrower than 36 inches, it is desirable that the bearings of the rolls be moved inward in order to reduce roll deflection. This is accomplished by making the bearing housings or supports movable upon the base plate and by bushing the rolls so that the bearings can run at any point desired.

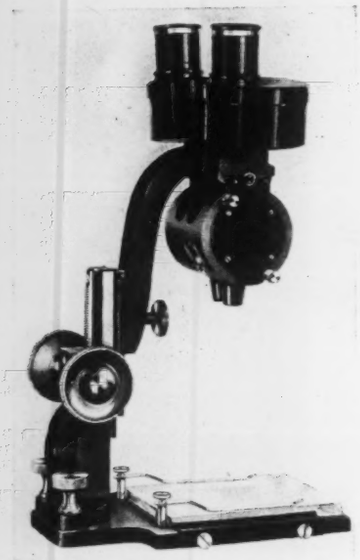


Fig. 5 — Stereoscopic microscope may be used for checking wearing surfaces or for examining castings, forgings or other parts

The rolls are geared together by intermeshing spur gears in four groups of three, each of which is driven from a top drive 17½ ratio worm reduction gear, the worm spindles being coupled together to form a continuous longitudinal line shaft. Worm wheel shafts of the worm gears are extended upon both sides, thus providing for the installation of a duplicate row of rolls on the opposite side of the worm gears. The motor is sufficiently powerful to operate both sets, although ordinarily only one side will be in use while the other side is being set up. The motor shaft, which runs at 860 revolutions per minute, is not directly connected to the line of worm spindles, but drives it through a helical reduction gear of 2.03 ratio. In case of long runs of the product both sides can be used to obtain double output.

This latter feature is particularly interesting from the point of view of possible application in the design of machines where reserve production facilities are desirable.

The Stereoscope Goes to Work

MOST of us can recall the old-fashioned stereoscope of our childhood days, with which we amused ourselves by looking at pictures in the parlor on rainy days. Long since passed into disuse as such, its principle has been revived and adapted to a modern industrial instrument. Thus a discarded toy has been the design inspiration for an industrial piece of equipment.

In the Bausch & Lomb binocular stereoscopic microscope illustrated in Fig. 5, the double optical system permits a stereoscopic effect or sense of depth which is extremely valuable in the machine shop. Surface quality has become a matter of much concern to designers in selecting materials, and to understand how a surface will wear or how it will resist corrosion, it is necessary to magnify it. The stereoscopic vision of this microscope permits an accurate examination of the surface characteristics, since the depth of vision is pronounced. It can be used for examining castings, forgings, etc., for cracks, flaws and blowholes. It also is well adopted for the inspection of machinery for evidence of wear after operation.

Equalizes Wear on Clutch Shoes

NEW uses for right and left hand threaded studs constantly are developing. The principle now has been applied to a friction clutch designed by Duro-Friction Clutch Co., Grand Rapids, Mich., as shown in Fig. 6.

In this instance the threaded stud is turned by means of a spur pinion mounted between the right and left hand threads. The gear is rotated by a rack which slides in a groove cut in the shaft on which the clutch is mounted. On each end of the threaded portions of the

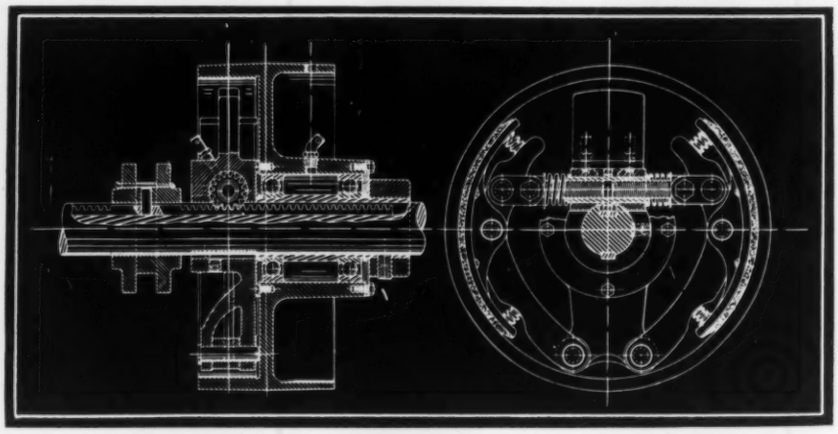


Fig. 6—Friction clutch shoes are operated by means of right and left hand threaded shaft

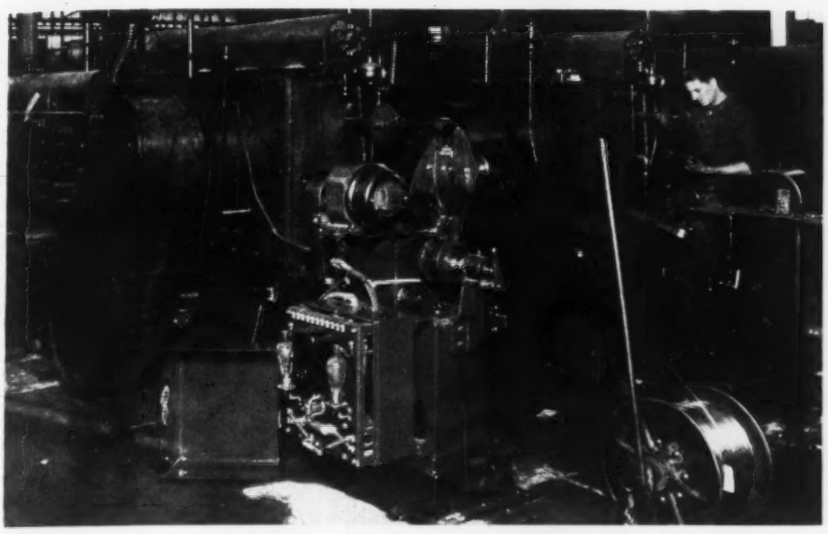


Fig. 7—Thyratron tubes are employed to obtain correct tension of wire in this wire drawing machine

stud is a coupling nut attached to the clutch shoe pivot member.

By movement of the rack sideways the threaded stud is turned, thus exerting equal pressure upon both clutch shoes. Adjustment can be taken care of readily by taking out the pivot link screws and rotating the right and left hand nuts one turn outward.

The Thyratron Tube in Design

USED formerly as a means for controlling theater light dimming, the Thyratron tube now is finding a definite place in design of machinery.

On a wire drawing machine installed at the Schenectady plant of the General Electric Co., on which it is necessary to keep the wire at the correct tension as it is reeled, Thyratron equipment has been installed to vary the speed of the re-reel spool.

The wire passes from a large reel through the wire drawing equipment, where it is drawn down to the desired size, thence to a small spool for re-reeling. As the wire is drawn at a constant rate, the speed of the re-reel spool constantly must be decreased as the effective diameter of the surface on which the wire is wound increases.

A small direct current motor drives the re-reel spool, power being supplied to the motor armature by the Thyratron tubes. A small reactor controls the power supply by the tubes. This control is determined by the position of the core in the reactor, and the position of the core is governed by the re-reeling operation itself. The wire runs over a rider pulley mechanically connected to the reactor core. As the loop on which the rider pulley rides decreases when the re-reel motor is running too fast, the core is drawn into the reactor, increasing its reactance and causing the tubes to pass less current, thus causing the motor to slow down. Conversely, if the loop increases in length the reactor core is withdrawn causing the tubes to pass more current and so increase the motor speed.

Very little work is done by the rider pulley. The reactor core weighs but a few ounces, while the current controlled by the tubes can be sufficient to control the speed of a motor of several horsepower. In this installation the tubes control the armature current to a ¾-horsepower motor with the field excited from a separate source of direct current, but a similar control unit could be used to control a motor many times as large by supplying and regulating the field current instead.

Provision is made so that failure of either the alternating or direct current, or breaking of the wire, causes a shut-down not only of the re-wind motor but also of the main motor.

Motor Has Remarkable Record

STILL efficient after 21 years of severe service in a textile mill, is the record of a Westinghouse motor, recently overhauled in the Pittsburgh service shop. The motor, shown in the accompanying photograph, has been used on a waste chopper in a textile mill. It was extremely dirty with lint and dust, the ends of the coils being barely discernible. Lint was piled up to the edge of the blower fins and the holes through the rotor core were filled.

Motor after 21 years' use on waste chopper

In its long service the motor bearings were rebabbitted three times due to lint filling the oil reservoir and preventing oil rings turning.

Chart Proves Advantageous in Rapid Shaft Design

By R. R. Slaymaker

Assistant Professor Mechanical Engineering, Southern Methodist University

EMPLOYMENT of the accompanying chart can be resorted to with advantage in designing steel shafts of circular cross-section, by any of the following five formulas:

$$(1)\ 2M = S_t = \frac{J}{r} \quad (2)\ T = S_s \frac{J}{r} \quad (3)\ \sqrt{M^2 + T^2} = S_s \frac{J}{r}$$

$$(4)\ M + \sqrt{M^2 + T^2} = S_t \frac{J}{r} \text{ and}$$

$$(5)\ 0.7(M + 1.86\sqrt{M^2 + T^2}) = S_t \frac{J}{r}$$

in which M = bending moment in pound-inches; T = torque in pound-inches; S_t = allowable bending stress in pounds per square inch; S_s = allowable shearing stress in pounds per square inch; J/r = polar section modulus of section in inches^3.

It will be noticed that the right side of all five equations is made the same, that is, a stress times the polar section modulus J/r. The reason for this will be explained later.

Equation (1) is recognized readily to be the flexure formula, usually written

$$M = S \frac{I}{c}$$

I/c for a circle, however, is $J/2r$, hence formula (1).

Equation (2) is the familiar torsion formula.

Formula (3) is the maximum shearing stress theory for failure by combined bending and twisting. The quantity $\sqrt{M^2 + T^2}$ often is called equivalent torque because of its similarity to the part played by T in equation (2).

Formula (4) is the maximum normal stress theory for failure by combined bending and twisting. It is most generally written

$$\frac{M + \sqrt{M^2 + T^2}}{2} = S_t \frac{I}{c}$$

in which the left hand quantity may be termed equivalent bending moment because of its similarity to M in the flexure formula. For use with the chart, however, it is necessary to put the right side of the equation in terms of a stress times the polar section modulus. This can be done, as in equation (1), by substituting $J/2r$ for I/c, the result being equation (4).

Formula (5) is a statement of Saint Venant's maximum strain theory applied to shafts subjected to both bending and twisting. The constants in this equation are found from assuming a value of 0.3 for Poisson's ratio.

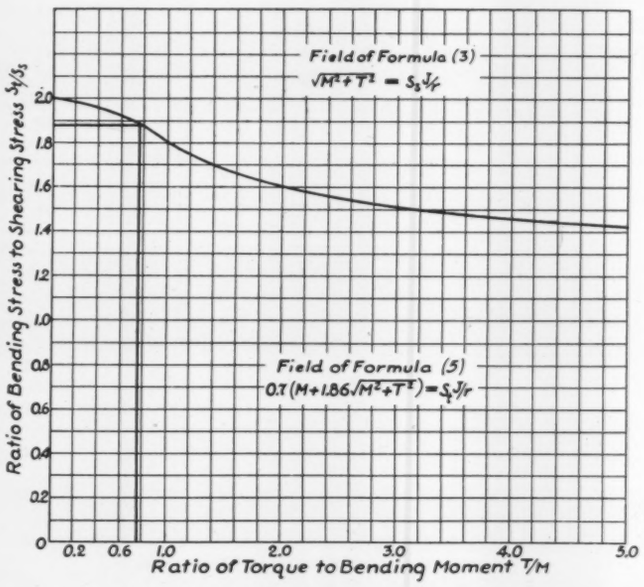


Fig. 1—Curve for finding relation between moment and torque

There are three possibilities of failure by combined stress: first, the shaft may fail in shear as indicated by equation (3); second, by bending as in equation (4); and third, in a manner expressed by equation (5). After considering formulas (4) and (5), it should be seen that (5) will always give a larger shaft diameter. This indicates that (4) should be discarded for (5). Disregarding (4) leaves a choice of either (3) or (5). That is, for any particular diameter of shaft, the shearing stress calculated from (3) might exceed the allowable value, while the bending stress calculated from (5) might be well within the safe range. This could be true, of course, only when the torque is large in proportion to the moment. On the other hand, if the moment were large in proportion to the torque, the bending stress from (5) might exceed the allowable

value, while the shearing stress from (3) might be low enough. It is advisable then, to have some means of knowing the proper relation between moment and torque so that we may decide in advance which of the two formulas to use without calculating the diameter from each. The curve shown in Fig. 1 provides this information. Here the ratio of allowable bending stress to shearing stress, S_t/S_s, is plotted against the ratio of torque to moment T/M. If the intersection of S_t/S_s with T/M falls below the curve, formula (5) will give the larger shaft and should be used. Conversely, if the intersection falls above the curve, formula (3) should be used.

Use of the chart given in Fig. 2 can best be shown by a series of illustrative problems:

PROBLEM I. In which the shaft is required to transmit torque only.

Find the diameter of a shaft to transmit 177 horsepower at 120 revolutions per minute, and not exceed a shearing stress of 7000 pounds per square inch.

Solution:

From the formula $T = 63{,}025\ HP/N$, the torque is found to be 93,000 pound-inches. Use scale A of the chart to represent torque, each unit being 10,000 pound-inches. Scale B represents stress in thousands of pounds per square inch and the shaft diameters are taken from one of the three figures on the diagonal lines. Follow 93 on scale A horizontally to the intersection with 7 on scale B (see point F on chart). Point F lies between one diagonal bearing the figures 0.862 — 1.86 — 4.0 and another bearing 0.883 — 1.90 — 4.1. To decide which of the three figures to use for the shaft diameter, observe the following rule:

When the units of scale A represent hundreds of pound-inches, use the smallest of the three figures on the diagonal lines. If the units of scale A represent thousands of pound-inches, use the middle figure on the diagonal lines for the shaft diameter. If scale A represents tens of thousands, use the largest figure for the diameter of the shaft; and if A represents hundreds of thousands, use ten times the smallest figure—etc.

Since each unit of scale A in this problem represents 10,000 pound-inches, use the largest of the three figures. The diameter, then is between 4.0 and 4.1, say 4.07 inches. Had the torque been 9300 pound-inches, the shaft diameter would have been taken from the middle of the three figures or between 1.86 and 1.90 inches. Further, had the torque been 930 pound-inches, the shaft would have been between 0.862 and 0.883 inch in diameter.

Had this problem been solved analytically,

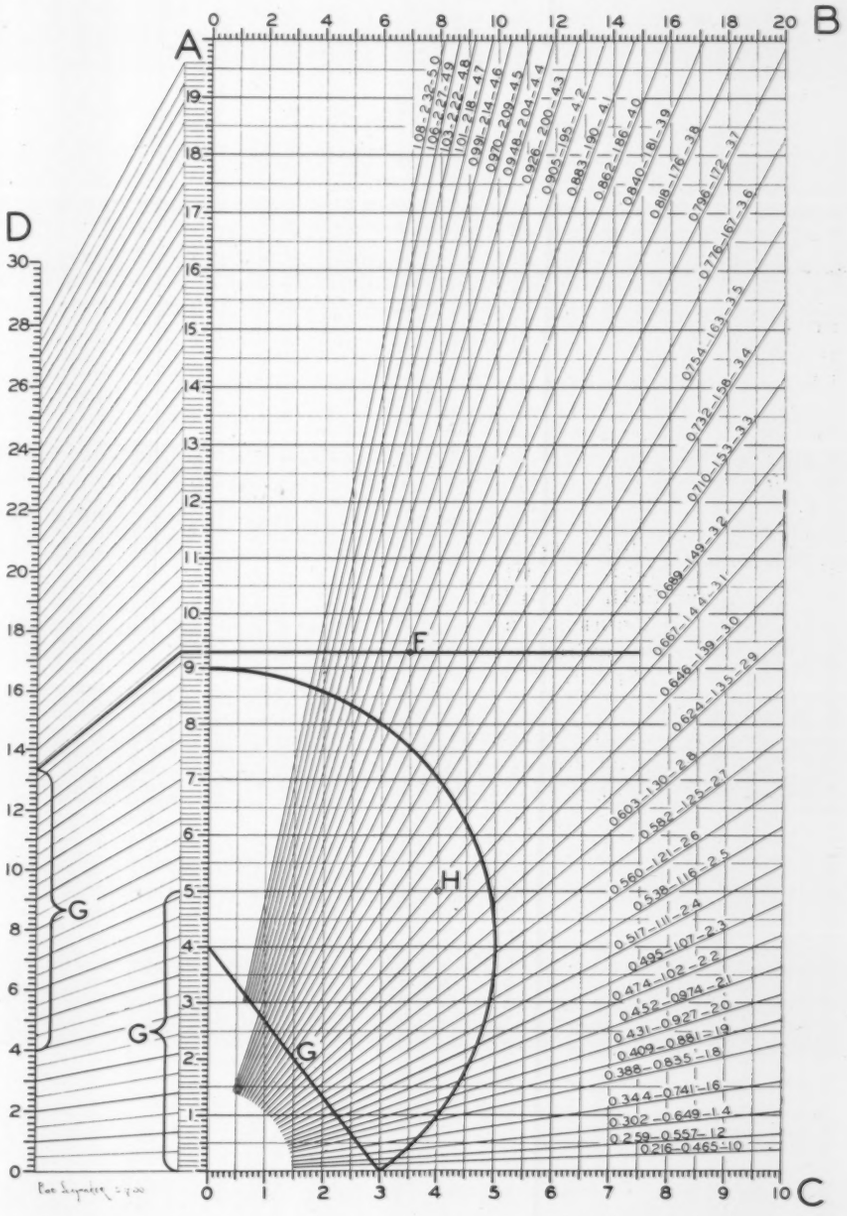


Fig. 2—Chart for determining shaft diameters

equation (2) would have been used to find that

$$d = \left(\frac{16}{\pi} \times \frac{93{,}000}{7{,}000}\right)^{\frac{1}{3}} = 4.07''$$

PROBLEM 2. In which the shaft is a beam subjected to bending only.

Determine the diameter of a shaft subjected to a bending moment of 93,000 pound-inches. Fiber stress 15,000 pounds per square inch.

Solution:

Follow 93 on scale A as before, to 15 on scale B to read diameter between 3.1 and 3.2 on the diagonal lines. (See heavy horizontal line on chart.)

Notice that in the solution of problems 1 and 2 only scales A and B were used. The use of the other scales will be explained in the next example.

PROBLEM 3. In which the shaft is subjected to both bending and twisting.

A shaft is subjected to a torque of 30,000 pound-inches and a moment of 40,000 pound-inches, the allowable shearing stress being 8,000 pounds per square inch and the bending stress 15,000 pounds per square inch. Find the shaft diameter.

Solution:

Since the shaft is subjected to both bending and twisting, it is necessary to know which of the combined stress formulas to use, (3) or (5). The use of (4), as previously stated, is unnecessary. To decide between (3) and (5), make use of the curve in Fig. 1.

$$\frac{S_t}{S_s} = \frac{15{,}000}{8{,}000} \quad 1.875 \quad \text{and} \quad \frac{T}{M} = \frac{30{,}000}{40{,}000} \quad 0.75$$

As shown by the heavy lines on the figure, the intersection seems to fall on the curve, which indicates that both formulas will give the same diameter and it makes no difference which one is used. For the sake of illustration, however, formulas (3), (4) and (5) will all be solved by means of the chart.

Scale C represents torque in pound-inches, the units being the same as scale A, and is used only to determine the $\sqrt{M^2 + T^2}$ as indicated by the heavy line marked G.

To solve formula (3) place a pair of dividers, as shown by diagonal line G, from 4 on scale A to 3 on scale C. From this $\sqrt{M^2 + T^2}$ is found to be 50,000. Now follow the horizontal line 5 on scale A to the allowable shearing stress, 8 on scale B. This point, marked H on the chart, lies between diagonals marked 0.667 — 1.44 — 3.1 and 0.689 — 1.49 — 3.2. Say $d = 3.16$ inches. Note that had $\sqrt{M^2 + T^2}$ been 5000 instead of 50,000 the diameter would have been about 1.47, and had the $\sqrt{M^2 + T^2}$ been 500,000 the diameter would have been ten times the smallest number, say 6.7 inches.

Should the designer choose to use formula (4), the $\sqrt{M^2 + T^2}$ can be determined as before. Using the point 4 on scale A as a center, he can swing the arc, shown in heavy line, and will find that $M + \sqrt{M^2 + T^2}$ is 90,000 pound-inches. Following the horizontal line 9 to the intersection with 15 (allowable stress) on scale B shows the shaft diameter to be nearer 3.1 inches than 3.2 inches, say 3.12 inches.

When formula (5) is used, it should be noticed that scale D is graduated to read 1.86 times scale A and that the diagonal lines from scale D to A read 0.7 of scale D on scale A. Thus the value of 0.7 $(M + 1.86\sqrt{M^2 + T^2})$ can be found by placing one leg of the dividers (set for $\sqrt{M^2 + T^2}$ or distance G) on the value of the moment (40,000 pound-inches) on scale D and the other leg will fall on 133,000 pound-inches, which actually is $M + 1.86\sqrt{M^2 + T^2}$. In order to determine 0.7 $(M + 1.86\sqrt{M^2 + T^2})$, follow the diagonal line from 133,000 on scale D to 93,000 on scale A.

Follow the horizontal line marked 93 to its intersection with the allowable stress line 15 on scale B to read the diameter of the shaft to be between 3.1 and 3.2, say 3.16. Notice that the diameter obtained from formula (5) is larger than the one obtained from formula (4) which substantiates the statement made above, that (5) will give larger results than (4).

Develops Hottest Spot Known, with Electric Arc in Vacuum

WHAT is believed to be the hottest spot in the universe is shown by Dr. J. Slepian of the Westinghouse research laboratories. In nearly a perfect vacuum, electricity creates a spot of heat calculated to be 900,000 degrees Fahrenheit. This is approximately 90 times as hot as the sun.

There is no thermometer which will measure so high a temperature directly. Therefore, the temperature is calculated by measuring the velocity of the molecules of the electrode metal which has been "boiled away" by the intense heat. This hottest spot in the universe was developed at the laboratories by Ragnar Tanberg while investigating the characteristics of electric arcs in a vacuum.

Apparatus used to develop 900,000 degrees of heat

Properties and Uses of Nitrided Steel

By H. A. DeFries

PRODUCTION of extreme hardness and wear resistance, combined with toughness and high impact strength, without material deformation or distortion, has for many years been the goal of both makers and users of steel.

Whether the requirements call for tool steels, automotive structural steels or case-carburizing steels, the ultimate hardening has always depended upon the presence of one element: carbon. In tool and automotive steels, carbon is introduced into the steel at the time of manufacture. In case-carburizing steels, the carbon is obtained through the well-known process of cementation. Unfortunately the mere addition of carbon is not sufficient to obtain the hardness and other properties required. All such steels must be heated to high temperatures, followed by subsequent quenching, in order to develop these properties, and it is a known fact that high temperatures followed by rapid cooling often defeat the purpose sought.

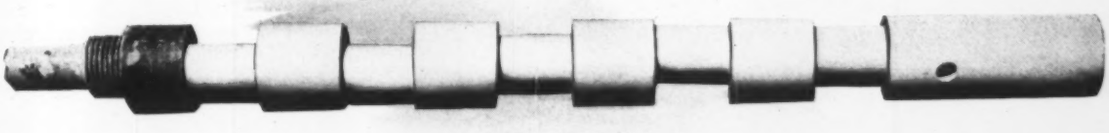
IN VIEW of the increasing importance rapidly being assumed in design by Nitralloy steel and the nitriding process, MACHINE DESIGN has obtained from Mr. De Fries, chief metallurgical engineer, Associated Alloy Steel Co., Cleveland, the accompanying comprehensive article on this subject.

Successful nitriding of steel through the medium of ammonia gas is due to a thorough study of the problem by Dr. Adolf Fry of the Krupp Research Laboratories at Essen, Germany, and later by investigations of Aubert & Duval Freres, Paris, France, and metallurgists of the Ludlum Steel Company.

From these investigations has developed the manufacture of a series of alloy steels containing varying amounts of carbon, together with approximately 1.0 per cent aluminum, 1.0 per cent chromium and 0.2 per cent molybdenum. Alloy steels having this particular combination of alloying elements were chosen because they showed the maximum surface hardness when exposed to ammonia gas under definite conditions. Furthermore, this hardness is retained at elevated temperatures and the alloys possess a marked resistance to atmospheric water and salt water corrosion. These steels are marketed under the name of "Nitralloy," the different ranges of carbon content being designated as grades "G," "H," and so on. The process of case-hardening with ammonia gas at low temperatures is termed "nitriding." Temperatures generally range from 900 to 1,100 degrees Fahrenheit, 950 degrees being the most common.

The Fry process for case-hardening with ammonia offers many decided advantages in that all of the heat treating of the articles is done before nitriding and no further treatment is

Fig. 1—Camshaft for feed lubricators used on locomotives, made from nitralloy and hardened by the nitriding process



necessary after their exposure to the ammonia gas. The temperature used is so low that no appreciable warping or distortion will take place provided the strains produced in machining and in hardening have been removed previously from the parts.

In order to satisfy varying requirements as

Fig. 2—Sprayer nozzles for severe service on which the new process has been applied

to core strength Nitralloy is produced in a number of different types. Addition of a definite percentage of aluminum in all types is strongly recommended, both on account of the extreme hardness which this element imparts to the surface of the steel when subjected to the action of the nitrogen in the ammonia gas, and also because of excellent physical properties produced in the core.

Because carbon has little effect on either the hardness or the depth of the nitrided case, this element is present only for its effect upon the physical properties of the core and is used in smaller amounts than is customary in most alloy steels. Analyses of two of the types produced are shown in Table I.

Physical properties are given in Tables II and

TABLE I

Typical Nitralloy Analyses

Element	Grade G	Grade H
Carbon	.36	.23
Manganese	.51	.51
Silicon	.27	.20
Aluminum	1.23	1.24
Chromium	1.49	1.58
Sulphur	.010	.011
Phosphorus	.013	.011
Molybdenum	.18	.20

III. Standard specimens (0.505-inch diameter and 2 inches gage length) were used for the tensile tests. The tensile test pieces were quenched in oil after 30 minutes' heating at 1750 degrees Fahr. and then drawn at the indicated temperatures for one hour. The Charpy specimens were treated in the same manner. Values for samples of grades G and H in the annealed condition are inserted for purposes of comparison after the figures for the quenched and drawn samples.

Manufacture of parts from Nitralloy does not differ materially from the shop methods commonly employed. Where high physical properties are necessary, normalizing followed by an oil quench and draw are used, as is customary in the treatment of the present types of alloy steel. If such refinement is carried out to the utmost the best and most ductile nitrided cases are obtained.

As stated in general terms, the pre-nitriding operations can be summed up as follows: The steel must be heat treated to impart the proper structure and the desired physical properties to the core and machined as usual. Before nitriding, all strains set up by forging or heavy

TABLE II

Physical Properties, Grade G

Drawing Temperatures	Yield Point	Maximum Strength	Elongation % in 2"	Reduction of Area	Charpy Ft.-Lbs.	Brinell
900	165,000	206,300	11.5	37.5	15	415
1000	158,500	182,500	15	50	22	363
1100	137,500	156,000	16.5	57	35.2	330
1200	120,000	138,000	20	60	44.0	285
1300	103,300	121,000	23	62.5	55.3	226
1400	80,500	104,300	28	59	54.5	200
Annealed at 1450° F.	69,000	95,000	30	67.5	31.6	186

machining must be thoroughly relieved by the recommended annealing treatment.

Preliminary Operation Schedules

A. For sections not requiring heat treatment. Use either G or H annealed.
   1. Machine, grind, and polish to exact finish dimensions.

      Under this heading come parts which are made in one operation on automatic machinery and where it is impossible for fabricator to apply stress relieving anneal between operations. It is obvious that this treatment applies to parts of simple design and where wear resistance only is required.

B. For simple sections machined from annealed bar stock and requiring heat treatment. Use either grade G or H annealed.
   1. Cut blanks or rough-machine the parts from annealed stock.
   2. Heat treat.
   3. Draw at proper temperature for four hours.
   4. Finish-machine, grind, and polish.

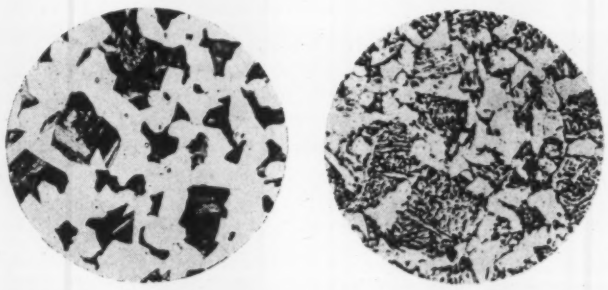
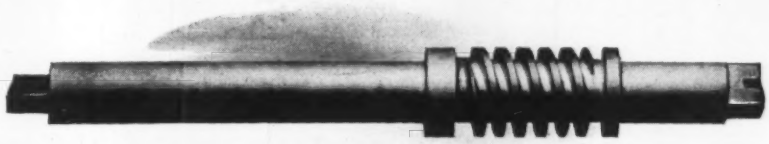


Fig. 3—(Left)—Photomicrograph of forged nitralloy. (Right)—Annealed nitralloy

C. For forgings, etc., not requiring heat treatment for definite physicals but where machinability is desired. Use grade G or H.

1. Forge the same as S. A. E. steels.
2. Normalize forging at 1800-1900 degrees Fahr. for one hour for each inch of minimum thickness, air cool.
3. Draw normalized forging at 1250-1300 degrees Fahr. for two to four hours depending upon thickness.
4. Rough-machine.



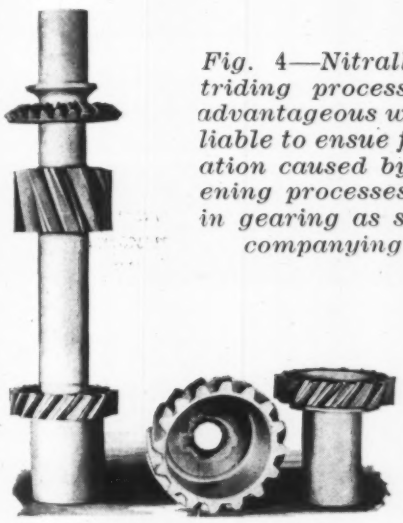


Fig. 4—Nitralloy and the nitriding process are extremely advantageous where difficulty is liable to ensue from the deformation caused by standard hardening processes. For instance, in gearing as shown in the accompanying illustrations

5. Reheat at 1000-1200 degrees Fahr. for 4 to 5 hours.
6. Finish-machine, grind, and polish.

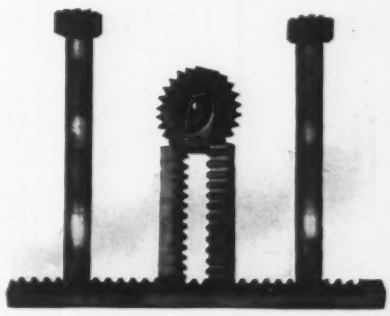
D. For forgings and complicated machined sections requiring heat treatment for definite physical properties. Use grade G or H.

1. If forging, forge as S. A. E. steels.
2. Normalize at 1800-1900 degrees Fahr. for one hour for each inch of thickness, air cool.
3. Heat normalized parts to 1750 degrees Fahr., hold one hour per each inch of minimum thickness, quench in oil and draw at 1250-1300 degrees Fahr.
4. Rough-machine.
5. Reheat at 1000-1200 degrees Fahr. for 4 to 5 hours.
6. Finish-machine, grind, and lap.

It is of the utmost importance in the case of all quenched and drawn parts, which are reheated afterwards, that drawing and reheating temperatures be equal to, or higher than, the nitriding temperature.

After nitriding, the parts which have been treated will be free from distortion or irregular growth exactly in proportion to the care taken in carrying out the instructions given for heat treatment and relief of stresses. All scale, resulting from forging or heat treatment, should be completely removed from surfaces that are to be subsequently nitride-hardened. Parts of steel articles such as threaded sections that must be kept soft can be protected.

The case produced by nitriding is approximately .031-inch deep. About one-half of this case is of extreme hardness and is clearly visible in the fractured sample. Hardness decreases



gradually until the case merges into the core without any line of demarcation. The fact that only the outer half of the case is visible to the naked eye may mislead the casual observer.

Under these circumstances, it is obvious that nitrided parts cannot suffer from spalling or exfoliation as so frequently occurs in parts poorly carburized. In certain cases, however,

TABLE III

Physical Properties, Grade H

Drawing Temperatures	Yield Point	Maximum Strength	Elongation % in 2"	Reduction of Area	Charpy Ft.-Lbs.	Brinell
900	143,500	170,000	16	49	25.5	365
1000	133,300	160,000	17	54	30.1	340
1100	117,500	134,500	18	61	48.1	290
1200	103,800	122,000	21.5	67	59.2	255
1300	85,500	102,500	27	72	69.0	228
1400	75,000	90,500	32	73	73.0	190
Annealed	60,000	80,000	34	70.5	47.8	157

where either too little attention has been paid to the relieving of sharp corners before nitriding, or the preliminary treatments have been carelessly carried out, it is noticed that microscopic layers tend to chip off. Such layers differ from ordinary spalling in that they have no appreciable depth, being in fact a mechanical removal of the thin film of oxide which forms on the surface during the nitriding treatment and which is not a part of the case proper, usually

being removed with fine emery cloth or buffed away before parts are put into service. This condition should not, of course, be confused with isolated cases of actual chipping caused by faulty design, accidents in transit or actual abuse, for it must at all times be borne in mind that in the nitrided case we have a material measurably harder than any steel heretofore produced which, naturally, cannot be as tough as a softer material.

Such extreme hardness as that produced by nitriding is beyond the effective range of the usual methods of hardness testing. The most reliable and uniform results thus far have been secured by use of the scratch test, the Herbert pendulum hardness tester and the Vickers machine. When converted into terms of Brinell figures, Herbert tests show as high as 900 to 1100 Brinell.

For sections which must be produced to particularly close tolerances, the nitriding process offers the advantage that the work may be finished practically exact to the desired dimensions without fear of material distortion during hardening. However, as mentioned before, during nitriding there is a slight growth due to the absorption of nitrogen. That the change in dimensions is but slight can be seen from the table following, which gives the measurements on a typical test piece, both before and after nitriding. The piece was nitrided at 930 degrees Fahr. for 96 hours.

Before	1.00144	1.00110	1.00086	5.981
After	1.00256	1.00220	1.00182	5.984
Change	0.00112	0.00110	0.00096	0.003

This growth can be allowed for in the finishing of the piece for hardening or provides material for slight lapping operations after hardening, thus rectifying any slight movement caused by the presence of unrelieved strains.

Growth of distortion in excess of the normal figures is an indication that the instructions covering the preliminary forgings, machining, and annealing operations were not carefully followed. It is, therefore, strongly recommended that no attempt be made to eliminate what might be considered unnecessary operations in preparing the first test parts for nitriding. After the material and process have been tested thoroughly and proven satisfactory under the conditions prescribed, it is then sufficiently soon to attempt in subsequent tests to cut costs by shortening the time consumed in preparing the work for the hardening process.

Resists Alternating Stresses

While no laboratory tests have as yet been carried in this country, European tests indicate an unusually high resistance on the part of nitrided sections to alternating stresses, and service tests on parts of this kind in America confirm this statement. It also has been noted that nitride hardened shafts can suffer considerable elastic deformation and still return to their original straightness after the load has been removed, provided they have not been stressed beyond the point where the case starts to crack.

Fig. 5—As may be seen from this photograph, nitralloy has innumerable applications. It has been used successfully for bushings, cams, cylinders, wrist pins, etc.

Nitrided case retains its maximum hardness when reheated, remaining file hard up to 1200 degrees Fahr. This is a desirable characteristic hitherto unobtainable, since ordinarily alloy steels hardened by quenching start to lose their hardness appreciably when the drawing temperature exceeds 350-400 degrees Fahr.

It early was noted that samples of Nitralloy after being nitrided did not rust insofar as atmospheric, fresh and salt water corrosion is concerned. A specimen has been subjected to the action of snow, rain and other weather conditions for almost a year and it still remains unattacked. Tests made in laboratories with standard solutions have proved its resistance to salt sprays. Tests with other reagents are not complete, but as yet no great acid resistance has been noted.

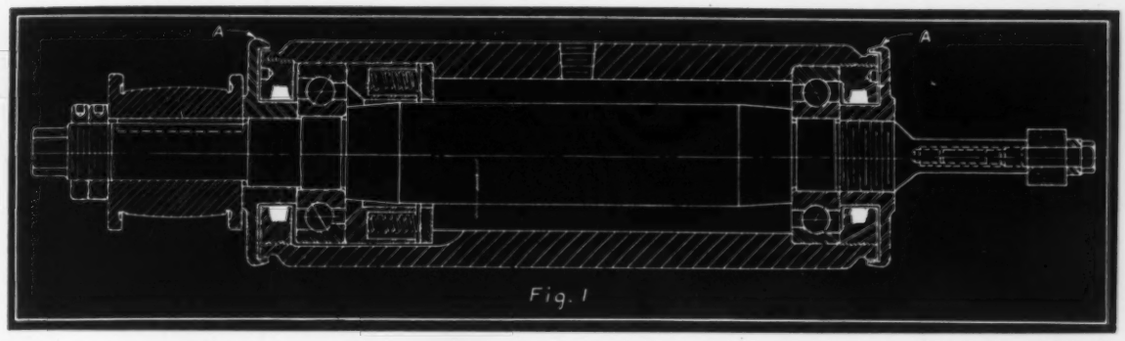


Fig. 1—Improved type of high speed spindle and mounting, showing the use of both felt and labyrinth seals for oil retention and protection against dust

Designing Spindles and Mountings for Extreme Speeds

By F. A. Firnhaber

THOUGH based primarily upon the design of grinding wheel spindles, the accompanying article contains enlightening information for consideration in design of other types of high speed shafts and mountings. Mr. Firnhaber has had extensive experience in this class of work and consequently is in a position to present an authoritative discussion.

OWING to the extremely high speeds at which a grinding wheel must run to be efficient, the correctly designed wheel spindle of today must be mounted on antifriction bearings of one type or another. In the following spindle designs, ball bearings have been used exclusively with the exception of one or two cases, and then partially.

Rigidity is an important requirement in the design of a grinding machine frame and bearing housing. This may be obtained in two ways, first, by mass or weight of metal, or secondly, by reinforcing ribs or webs. These ribs or webs must be of ample proportions to insure minimum defection under stress. Mass probably is better than weight, as it absorbs any tendency toward vibration which ordinarily would be transmitted from the wheel to the finished product.

The spindles should be of generous diameters for securing rigidity. Some spindle makers form that portion of the shaft between the bearings into a double cone shape, the large diameter being in the center of the two bearing shoulders. This tends to keep the spindle from whipping out of true at particularly high speeds. It also is desirable to keep the spindle as short as possible.

Accuracy in machining of the various parts should be stressed. Out of roundness of housing bores must be avoided. While many

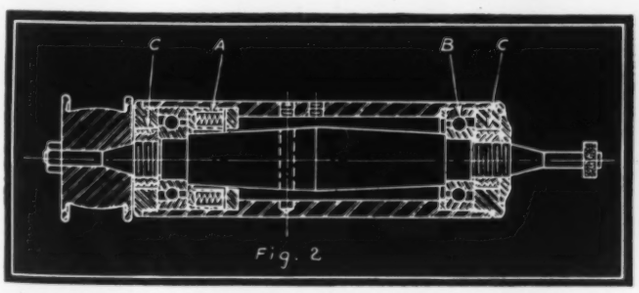


Fig. 2—Spring-adjusted bearing for light work. Springs at A exert 100 pounds initial load

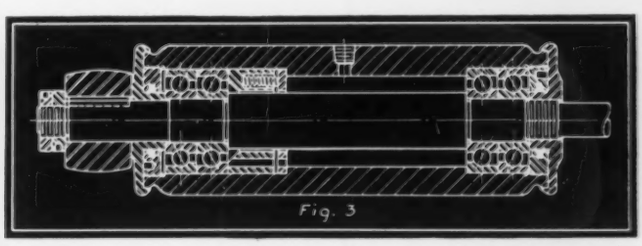


Fig. 3—Two bearings are mounted front and rear to permit higher spring pressures and considerably higher speeds, the load carried by each bearing being reduced

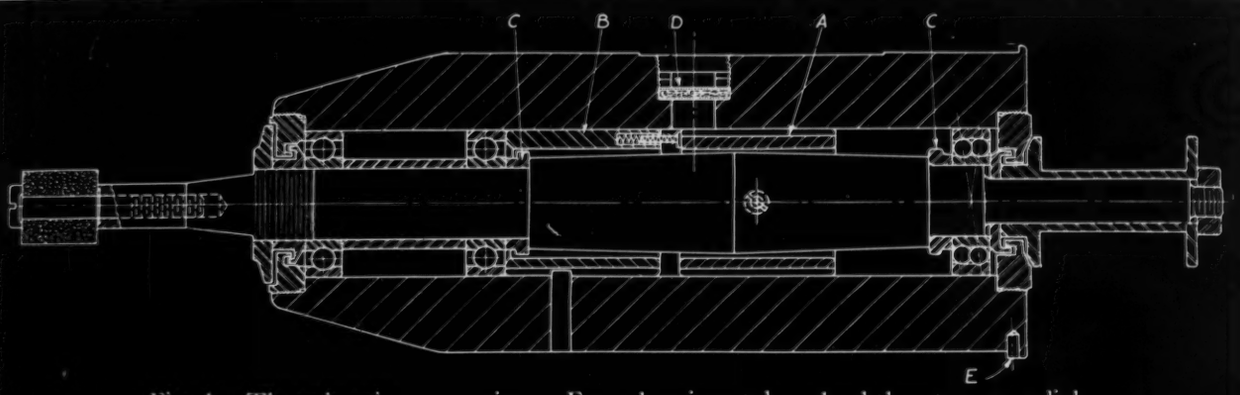


Fig. 4—Three-bearing mounting. Front bearings take wheel thrust; rear, radial pressure caused by the belt pull

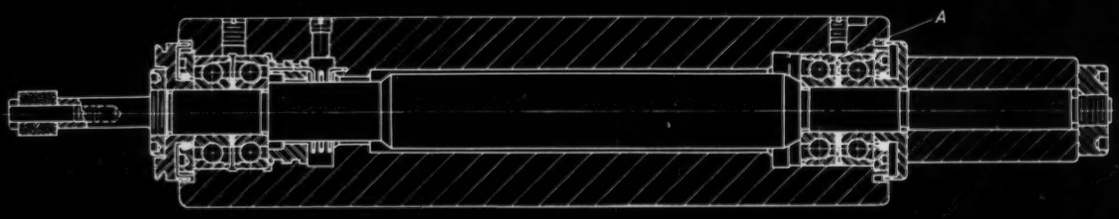


Fig. 5—Crimped spring washer is provided at *A* to take up bearing wear

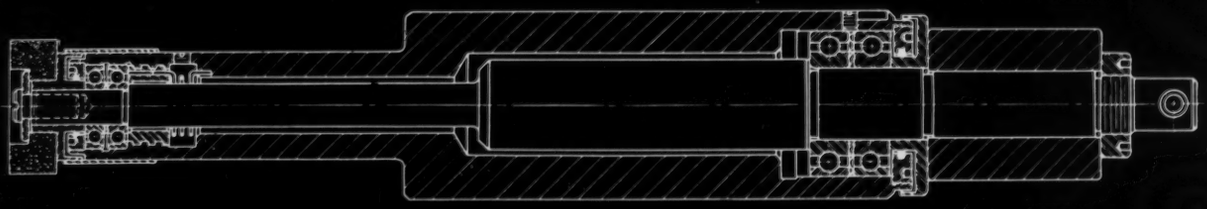
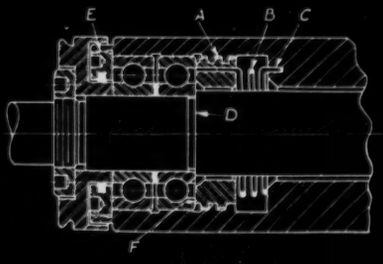


Fig. 6—Spindle and mounting designed for heavier work. This is a sleeve type, extended spindle

Fig. 7—(Right)—Enlarged view of automatic bearing tension adjuster used on spindles shown in two previous examples



Note the loosely threaded nut at *A* which is rotated by torsional spring *B* to take up wear in bearings

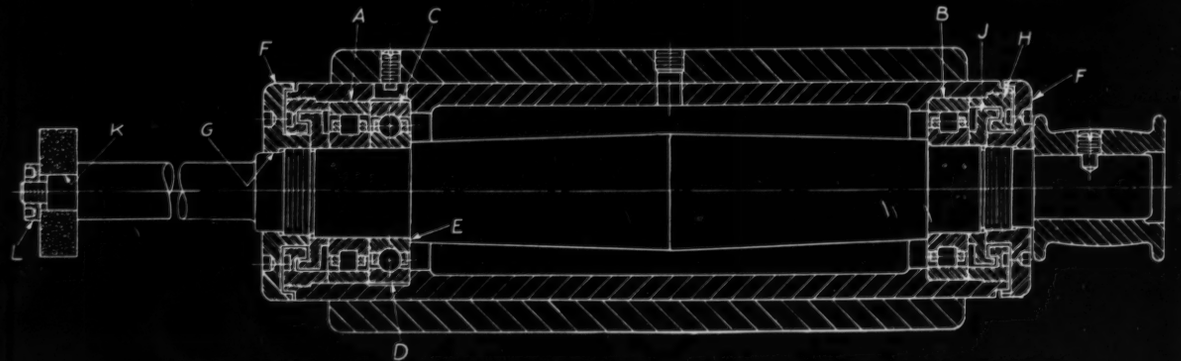


Fig. 8—Application of roller type bearings. Wheel end thrust is taken by ball bearing shown at *C*

spindle housings have bearing shoulders machined integral, great care should be exercised that these bores at either end of the sleeve line up accurately. Further on are shown examples where the sleeve is ground out to the outside diameter of the bearing for its entire length, necessitating only one set-up.

As a rule the bearing seats on the shaft are ground. The shoulders also should be ground at the same set-up. It takes but little time and assures trueness of seat. Accuracy also must be maintained in spacers and clamping nuts or collars as the alignment of the spindle is impaired through faulty machining. The ideal method would be to grind all faces where manufacturing costs are not prohibitive.

At extremely high speeds every rotative piece must be in balance. Spanner holes and slots should be equally spaced and it is better that there be more than two in number, preferably three or four. If screws are used to hold on the driving pulley, a long enough screw to fill the hole should be used, or if driven by a key, two keys and keyways are used in preference to one, or one key and three keyways would be better than one of each.

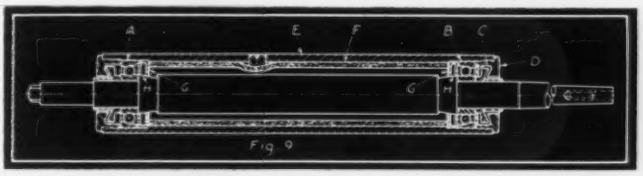


Fig. 9—Spindle designed to run at forty thousand revolutions per minute. Open type bearings are used, to allow for shaft extension due to heat

Bearing fits on the spindle and in the housing must be in accordance with the bearing maker's recommendations, this being particularly true if preloaded bearings are used in order to obtain the correct preload values. The bearing housing is ground or bored to a close slip or sucking fit. This allows the outer ring to creep very slowly when the spindle is in motion. It helps to distribute wear over the entire bearing surface of the outer race. If the fit is too tight between the shaft and the inner ring, the latter expands and tends to cramp the balls which immediately causes heat. The same is true with the outer ring, which closes in, causing the same trouble.

Factors Concerning Lubrication

Ball bearings used in spindles, regardless of their speed, do not use oil in great quantities and therefore should receive lubricant of the best quality obtainable. This lubricant should be as neutral as possible and should contain no acid or alkali, both of which will attack the mirror-like surfaces of the balls and races and cause them to corrode or rust. Mineral oils are used in preference to vegetable oils as the latter become rancid. Many manufacturers recommend sperm oil.

Grease usually is desirable for ball bearings running at moderately low speeds and oil for high speeds. The bearing manufacturer specifies in his manual many brands and viscosities at various speeds and he should be consulted in case of any indecision on part of the user. Some manufacturers recommend that at extremely high speeds ball bearings should not be fully or even partially submerged in oil, the ideal method for lubricant control being by a wick feed or sight feed oilers.

Wick Type Oil Feed Employed

It has been found that when oil is fed in drops upon rotating parts at speeds exceeding 8000 revolutions per minute, it is not properly atomized, but is thrown off by centrifugal action in large globules which do not readily enter the bearings. Therefore the wick type of feed is resorted to, which sucks the oil from the reservoir to tapered portions of the spindle proper, through contact with the ends of the wicking. This deposits a thin film of oil on the tapered surfaces where it is immediately thrown off and into the bearings. Wick type of lubrication has another advantage inasmuch as it filters the oil effectively of all grinding dust before it enters the bearings. The flow of lubricant may be controlled by compressing the wicking with a flat pointed screw which can be locked by a check nut.

Figs. 1, 2 and 3 show various types of mountings on ball bearings. In Fig. 3 is shown a design that was used successfully for the past fifteen years on precision bearing bores which required a fine finish. It is self-adjusting for bearing wear. While the load carrying capacity of a ball bearing is less at higher speeds, requiring a more careful control of the initial load, it can be obtained by springs as in Fig. 2. The springs *AA* force the outer race against the balls which in turn transmit this force to the inner race. This pulls the whole spindle towards the driving pulley end and finally brings the balls of the wheel end bearing against the outer race at *BB*. The main advantage is that the spring adjustment is automatic. Initial load which the springs exert in this spindle is 100 pounds, being for relatively light thrust loads.

Spring-adjusted bearing mountings have, however, a limited use. A rapidly reversing thrust load causes the springs to deflect slightly if they are not strong enough. This effects the finish and accuracy of precision work. The balls leave their angular contact between the inner and outer races and drop down into the bottom of the groove. Feed hesitation results, causing

chatter marks on the work. Heavy wheel thrusts and large radial shock loads should be avoided with this type of mounting.

The threaded collars at *C-C*, Fig. 2, are spirally groove grooved on their periphery to screw any grinding chips or dirt outwards. If these grooves run in one direction only, namely outwards, they tend also to screw the lubricant out of the spindle. The fault may be overcome by running the screwing-out groove only half way along the periphery of the collar and a groove of the opposite hand in the opposite direction. This eliminates dirt and retains the oil in the spindle.

Bearing Life Increased Four Times

Fig. 1 shows an improvement over the spindle shown in Fig. 2. Experiment has shown that with the improved dust seals of a semi-labyrinth and felt type, both front and rear, the life of the bearings was increased approximately four times. Incorporated was a change of ball retainer material from steel to a non-metallic substance. At *AA* are external slingers which throw off the grinding compound, preventing entrance into the bearings.

Fig. 3 has the same spring adjustment as previously explained, but has two bearings both front and rear. This permits a larger spring load which is divided over four bearings instead of two. The spring load should be as large as possible, but must be within the range of the bearing capacities. Double bearing mounting is better adaptable to higher speeds inasmuch as it cuts down the bearing size and consequently the surface speed at which the balls must run. This type of design is used readily at 30,000 revolutions per minute.

Fig. 4 shows a mounting of three bearings placed at intervals along the length of the sleeve. The two front bearings take the wheel thrust and are self-adjusting for bearing wear. The rear bearing is self-aligning and carries the radial thrust of the belt.

In this case the sleeve is ground to the bearing size along its entire length for ease of assembling. Spring retaining collar *A* is held in place by a screw, while collar *B*, which carries the springs, floats. Both collars are made long, to have good alignment. Collars *C-C* facilitate in disassembling the bearings when replacements are necessary, offering a shoulder with which to force the bearing off the shaft. The particular seal used here is known as the labyrinth or tongue and groove seal, and is effective in keeping out foreign material, the space between the various diameters being not more than .0005-inch to .0008-inch. The spindle is double cone shape between bearings to keep it from whipping.

Both the clamping screw and spindle wheel shoulder are relieved and the screw is piloted. A double wire mesh screen and felt at *D* strain the oil that is admitted. All spindles have a pin or key as at *E*, which locates the spindle housing always in the same position in the spindle carrying member.

In Figs. 5 and 6 are designs by Bryant Chucking Grinder Co. Fig. 5 is mounted front and rear on opposed open type ball bearings and is a plain type for small work, while Fig. 6 is a sleeve type of spindle for larger work. The outstanding feature of these spindles is shown in Fig. 7, an enlarged view of a successful automatic bearing tension adjustor which also compensates for wear. It consists of a loosely square-threaded nut *A* with a special torsional spring *B* behind it. This assembly is used only at the wheel end. When the spindle is assembled, the nut *A* is screwed back into the spindle housing, winding up the spring *B* of which one end is held in the housing at *C*, the other end in nut *A*. After the bearings are forced against shoulder *D* and nut *E* has been screwed home, the spring is released causing nut *A* to unscrew until it rests against the outer ring of bearing at *F*.

The outer rings of the pulley end bearings are separated by a crimped spring washer *A*, Fig. 5, which automatically takes up bearing

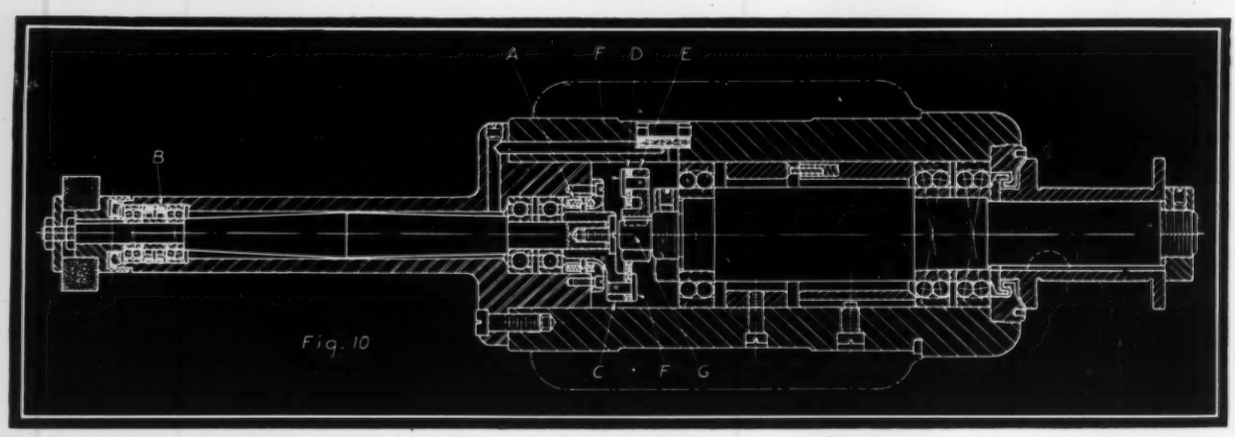


Fig. 10—Two unit arrangement consisting of spindle proper and rear unit carrying belt pulley. A balanced flexible coupling is employed between the two shafts

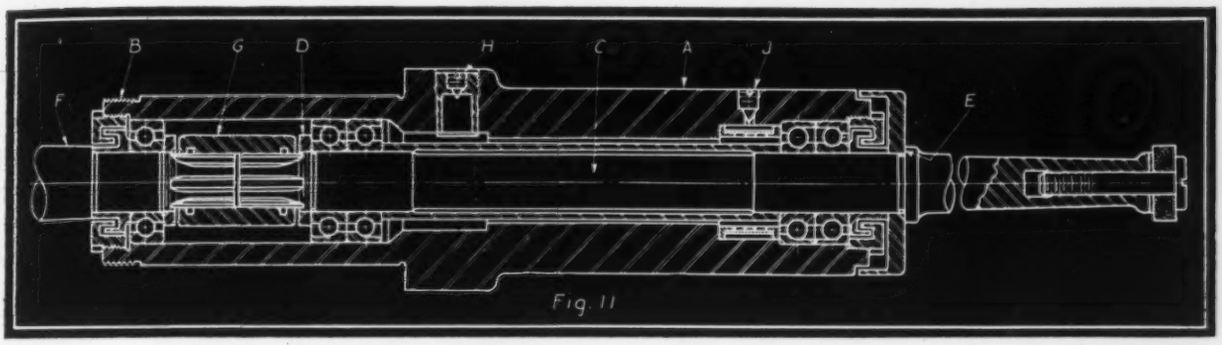


Fig. 11—This two unit design permits close spacing of antifriction bearings. Elimination of possibility of vibration thus is accomplished and smooth running assured

wear. This spring washer does not need as much adjustment as the spring *B*.

Until a few years ago the roller type of bearing was considered impractical for grinding wheel spindles. However, the installation shown in Fig. 8 discloses such an assembly. These roller bearings have stood up successfully at 35,000 revolutions per minute. Compared with ball bearings, size for size, they have a greater load carrying capacity radially, for belt pull and wheel pressure. They take no end thrust whatever.

Ball Bearing Takes End Thrust

At *A* and *B* are roller bearings and at *C* a deep groove ball bearing which alone takes the wheel end thrust. It will be noted that the latter has no radial contact in the housing as shown at *D*, being relieved at this point, but is held firmly against shoulder *E* by nut *F* which is piloted at *G*. It is most desirable in a design of any piece of machinery to make use of duplicate parts. The design under discussion lends itself to this feature, pieces *F*, *H* and *J* being the same as at the other end. Labyrinth oil seals are used at both ends.

Fig. 9 shows the Dumore No. 5 grinder spindle. It is designed to run up to 40,000 revolutions per minute. At this high speed the spindle must be in as nearly perfect dynamic balance as possible. It is made of tough heat treated steel and in the final grinding operation, the eccentricity of the various diameters cannot exceed .00025-inch. Shaft expansion and contraction was one of the problems of design, so open type ball bearings are used which will permit longitudinal motion. Bearing *A* is locked in place. Bearing *B* is backed by a special spring *C*, which compensates for the end motion caused by expansion. Spring *C* bears against the cap *D*. It is interesting to note that variation of room temperature and extreme heat will expand this spindle approximately .001-inch per inch of length between the two ball bearings.

The quill or housing *E* is made of heat treated or normalized cast iron with inside diameter ground to a permissible variation of .00015-inch. Specially selected ball bearings have been used on which the S. A. E. limits were split. The quill must be held to plus or minus of .001-inch in 8½-inch length. Care also is observed in machining the end caps to maintain the proper amount of clearance.

Lubrication presented a problem which was overcome in this way: A long cylindrical felt tube *F* extends the entire length of the inner portion of the quill between the bearings. It butts against two felt washers *GG*, of a design which permits contact with the tapered portions of the spindle *HH*, thus forming a complete contact with the felt tube *F*, which is saturated with fine oil. The action that takes place is as follows: When the spindle revolves there is a certain amount of heat created under the surface of the felt washers *GG*. This warmth hastens the phenomena of capillary attraction, which draws the oil from the long felt tube to the spindle. High speed of the shaft causes the accumulated oil to crawl to the high point of the taper where it is thrown directly into the ball bearing in the form of a mist. The labyrinth construction at both ends act as an impedance to the flow of oil. This type of lubrication requires removal of oil only once or twice a week under continuous service.

Springs Effect Automatic Adjustment

Fig. 10 shows a two unit sleeve type spindle for medium large and long work. The front end, consisting of the wheel spindle proper, is mounted on two floating self-aligning bearings directly behind the wheel and on two deep groove bearings at the rear of the unit for wheel thrust. In both mountings the bearing adjustment is accomplished automatically by the springs *A* and *B*. The rear unit carries the driving pulley and runs on three self-aligning bearings, spring adjusted as explained before in Fig. 4. These units are connected by a flexible coupling. Spider *C*, which also clamps the rear bearings of the front unit in place by means of a screw, carries a leather disc *D* which is connected to spider *E*. Each spider has three lugs

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Some Facts Concerning
Safety Devices for Machines

Stressing Advantages of Incorporating Various Safety Features In Original Design of Manufacturing Equipment

WHY should safety features be neglected in certain types of machines? There is no question that in many instances engineers responsible for design have given in-

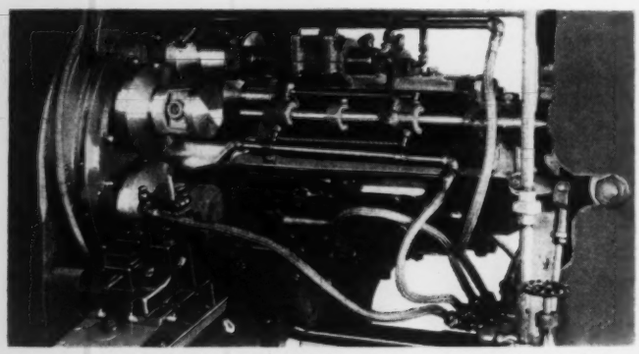

Fig. 1—Pedal is provided for operation of work locater. This also prevents turret indexing during loading and unloading

sufficient thought to the subject of providing equipment which can be operated with safety.

This condition has been the rule rather than the exception. Observation in practically any plant in which machines are installed discloses the fact that the maintenance engineer is the man who largely is compelled to shoulder the responsibility of making machinery safe.

An outstanding example of this is found in the number of machines used in various branches of industry which, when they are installed, have to be provided with such commonplace items as belt guards. Occasionally two or three per machine are required. Often so-called temporary guards are built, usually from wood, which are unsatisfactory and lend anything but an appearance of efficiency to the department in which they are used.

There is little excuse for not furnishing a machine, in its original design, with suitable guards. When the angle of drive to the machine (in case of lineshaft drive) is liable to change, adjustment usually can be provided, and in the case of gears or other moving parts not subject to change it is an easy matter to include guards in the specification. Where this is done, and the machine supplied to a user ready to operate, the salesman has a strong argument in favor of his machine, apart from mechanical operation.

Grinder Incorporates Safety Feature

There are innumerable parts or movements in machinery other than those mentioned in the foregoing which warrant attention from the aspect of safety in design. An example of such an instance is disclosed by Figs. 2 and 3 which illustrate a new type of high speed, heavy duty grinder announced recently by Kling Bros. Engineering Works, Chicago. The machine incorporates a novel safety device for eliminat-

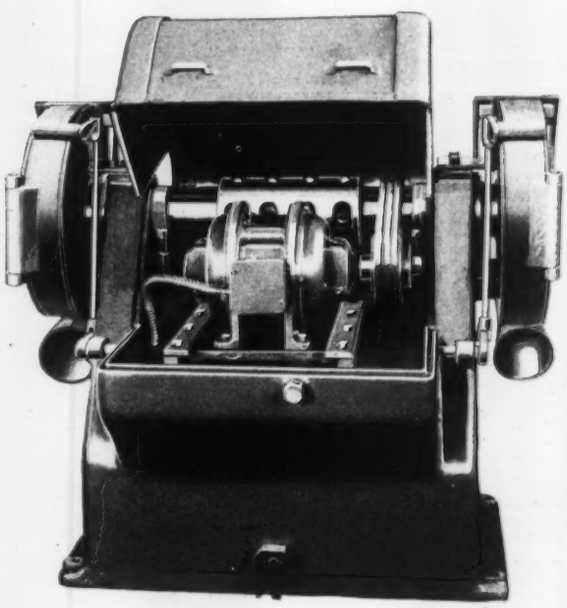

Fig. 2—New grinder incorporates device which eliminates possibility of running wheels at excessive speeds

ing the possibility of running the wheels above recommended speeds.

The arrangement consists of control arms located under the motor base, as shown in Fig. 3, which are actuated through connecting rods and levers by the raising and lowering of spark guards. As the wheels wear down in diameter the guards are moved down, thereby lowering control arms through the movement of the rods and levers.

Permits Increased Shaft Speed

When the wheels become worn down by use to the proper size for the next increase in speed the spark guards have been brought down far enough to have moved the control arms down to allow the motor base to pass over the first step of the control arms. It then is possible to mount the next size larger V-belt sheave on the motor shaft in order to increase the arbor shaft speed. This same condition exists for the next two changes in speed. It is, of course, impossible to raise the spark guards to permit mounting of new wheels until the motor has been brought back to its original position where the slow speed sheave can be employed. Thus

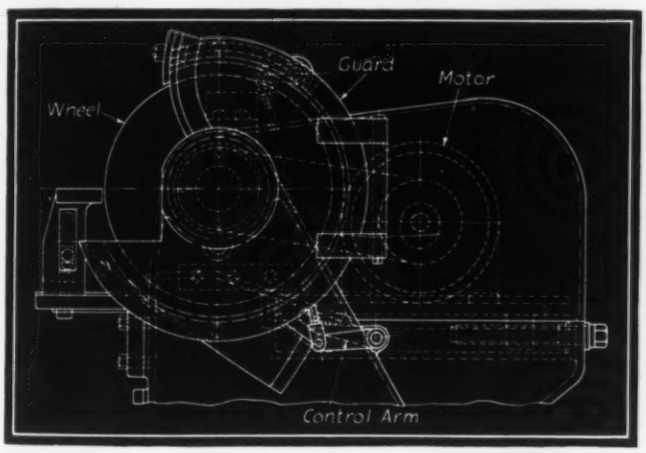

Fig. 3—Wheel guards are connected by rods and levers with stop arm under motor base

danger due to excessive speed of the wheel is obviated.

Another type of device for safeguarding the operator is incorporated in a chucking machine placed on the market recently by Baird Machine Co., Bridgeport, Conn. This machine performs a series of turning operations on cylindrical work, as indicated in Fig. 1., each operation being done at a certain position of the turret of the machine. The finished product and new work are transferred to and from the machine by hand.

During removal of the finished work it is necessary for the operator to place his foot on a pedal near the floor, thus withdrawing a locator used for positioning the work in the machine. Connected with the locator is a safety control

Fig. 4—Not original construction, but a very necessary adjunct to a press

by means of which the turret is prevented from indexing while the pedal is held down. Because of this the operator can load and unload with safety.

On machines requiring the services of more than one operator, it is most important that provision be made for each to stop the machine if necessary. This point is illustrated in the design of an automatic machine shown in Fig. 5, on which cigars are produced at a rate of seven or eight per minute. Three operators and an inspector are employed in running the machine, as seen in illustration. Operators' duties respectively are the placing of the filler tobacco leaf on the feed belt of the machine and the laying of the binder leaf and wrapper leaf on their trimming dies.

Leaves Are Trimmed to Shape

The latter two operations necessitate a fair amount of skill on the part of the operators in order to lay the binders and wrappers flat on the dies before trimming knives, which are swung out of position during these operations, return to their positions above the dies and cut the leaves to correct shapes. To provide sufficient time the machine is so designed that it stops automatically at this point in its cycle of operations. Each of the operators mentioned is provided with a foot pedal and the machine cannot start again until both pedals are pressed down. In practice the operators usually can keep the machine running continuously, being able to lay the tobacco leaves on the dies cor-

rectly during the time allowed by the machine. However, in case of difficulty the knowledge that the machine cannot restart until the foot pedal is depressed gives the operator full confidence in doing satisfactory work.

In addition to the foot controls three hand controls are provided at different points of the machine. With any one of these it is possible to stop the entire unit at any point in its cycle of operations. It will not restart until all three levers are in the starting position, thus insuring adequate protection both for the operators or, on occasion, the maintenance staff.

The device shown in Fig. 4, employed on stamping presses to prevent injury to the operator's hands, is worthy of note. It consists of two ropes passing over pulleys and down behind the operator, the ends of ropes being attached to two leather bands which the man fastens to his wrists. As the press descends, tension is exterted on these ropes and the operator's arms are pulled back from beneath the die. In this way it is impossible for him to have his hands under the dies as they are closing.

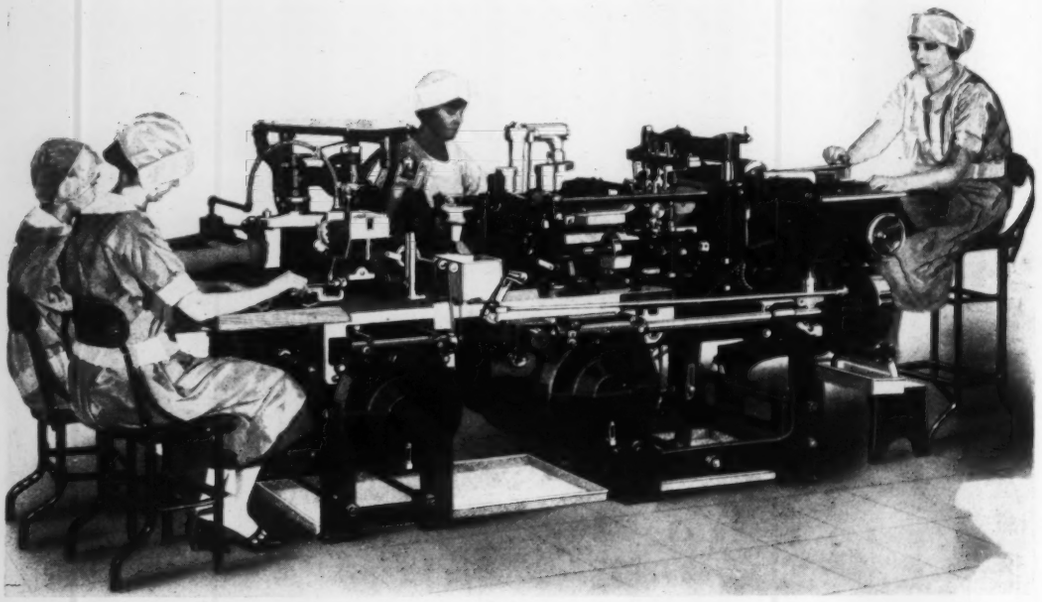

Fig. 5—On this cigar making machine two operators are provided with foot pedal controls. There also are three hand controls located at different points of the machine

Could Safety Feature Be Included?

In connection with this device the thought immediately arises "Was it not possible for the designer to incorporate the safety feature in the original design of the machine?" There are few places on machines where more damage is done to fingers and hands than between stamping dies or under punches. Yet these often are left entirely unguarded—surely an opportunity for the designer to display ingenuity.

Danger in operation is allied closely to fatigue and for this reason an opportunity will be taken to present a comment received from a reader of MACHINE DESIGN, C. G. Williams, chief engineer, Green Bay Barker Machine & Tool Works, Green Bay, Wis. This deals chiefly with the subject of noise in shops and its result—fatigue. Mr. Williams says:

"In the design of any product there are many conditions to be met that finally tie up in that one big phrase "adaptability to the work at hand." And now in your article, 'The Time Is Ripe for Engineers to Consider the Human Factor' you state that everyone has contributed to the welfare of the worker excepting the design profession. In this statement there seems to be so much to criticise that the great detriment to writing is to determine where to start.

"It would seem to me that the design profession always has considered the 'human factor'—that it set the ball rolling and that the rest are only kicking it around aimlessly. I wish you could see the shop of 35 years ago, in which I began my apprenticeship. There were machines, true, but they were not exactly suited to the comfort of the operator. It also is true that the old engine lathe, planer, drill press, punch press and shear have not changed to any great extent, insofar as appearance is concerned, but a close-up inspection will show many changes for the good of the operator as well as to increase the productivity of the machine. Any plans in design that tend to increase the productivity of the machine tie in so greatly with the comfort of the worker that a designer wonders why this sudden interest in the welfare of the worker. It is true that in some shops, especially in the sheet metal or boiler shops there seems to be a decided reversal. I recall to mind the boiler shop of a railroad in an Illinois town. When this shop was constructed, the shears and punches all were hy-

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Combinations in Mechanisms

By J. S. Beggs

ONE of the beliefs of Thomas A. Edison, in connection with design of automatic machinery, is that the principle of the Jacquard loom is the greatest reserve principle of the future. This places emphasis on the method of obtaining action in machine members by means of a combination of holes punched in a steel card or a paper roll. The following brief discussion deals directly, particularly in the second instance given, with an example of Mr. Edison's theory.

By arranging a few like elements of mechanism in different combinations of position the same effect may be obtained as by using a large number of different elements. In the linotype machine the mechanism for sorting the dies or matrices after the type has been cast, and dropping them into the correct magazine, consists of a long carrier bar of cross section as shown in Fig. 2, having seven pairs of ledges. The matrices, which hang by teeth from these ledges slide along the bar until they come over their own magazine. Here the ridges from which the matrix is hanging are cut away, allowing it to fall into the correct magazine. With these seven possible positions for the teeth on the slug we can form 127 different combinations, and thus sort 127 different matrices.

The number of different combinations we can form by choosing r things from among n is given by

$$\frac{n(n-1)\ (n-2)\ \ldots\ldots\ (n-r+2)\ (n-r+1)}{1 \times 2 \times 3 \times \ldots \times r}$$

The numerator is the product of the consecutive whole numbers from n down to n-r+1 inclusive, the denominator is the product of the consecutive whole numbers from one to r inclusive.

Therefore we can choose four things from among twelve in

$$\frac{12 \times 11 \times 10 \times 9}{1 \times 2 \times 3 \times 4} = 495 \text{ different ways}$$

Referring to the linotype again, we may use one pair of teeth to hold the slug, and there are seven possible positions on the slug for this one

Fig. 2—Cross section of linotype carrier bar

pair. Using two pairs we have to choose two positions from among seven. Using the formula we find the number of combinations to be

$$\frac{7 \times 6}{1 \times 2} = 21$$

Using three pairs of teeth the number of combinations is

$$\frac{7 \times 6 \times 5}{1 \times 2 \times 3} = 35$$

Summing up all possibilities,

Pairs of Teeth	Combinations
1	7
2	21
3	35
4	35
5	21
6	7
7	1
Total	127

It should be noted as a matter of application that the magazines for the matrices hanging by a smaller number of teeth must be placed before those for matrices hanging by a larger number, else the former would drop off before reaching their own magazine.

The transmitter of the printing telegraph uses combinations of holes in different positions in rows across a paper tape, as shown in Fig. 1, to operate the printer at the other end of the

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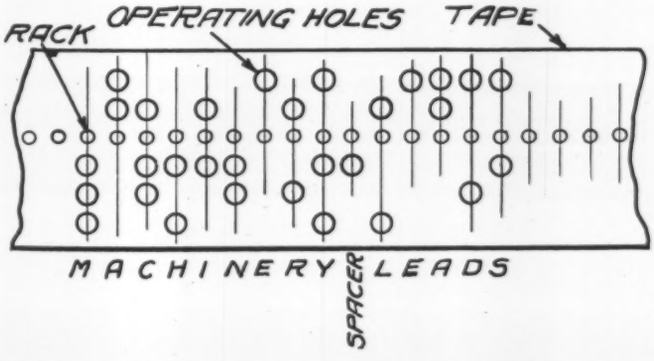


Fig. 1—Different combinations of holes in paper tape, as used in the printing telegraph

General Considerations in Designing Mechanical Springs

By A. M. Wahl

Part IV—Calculating Torsional and Spiral Springs

TORSIONAL and spiral springs often are used where it is desired to transmit torques or rotary motions. This type of spring is loaded in such a manner that the stresses set up are *flexural,* in contrast to the helical spring axially loaded which is stressed *torsionally.* In calculating a torsional or spiral spring we usually know the maximum bending moment applied. Knowing this the ordinary method of calculation is to assume that the formulas for straight bars apply or in other words to calculate the stress from the well known formula, S = bending moment/section modulus.

However, it is known that if a bending moment acts on a curved bar the true maximum stresses will be greater than those calculated by the ordinary beam theory, since in these cases the stress distribution will by hyperbolic. In Fig. 1 there is represented a straight bar under a bending moment M. In this case the stress distribution over the cross-section may be represented by the straight line shown. On the other hand, in the case of a curved bar acted on by a bending moment M as in Fig. 2 the stress distribution is hyperbolic, maximum stress occurring in the fibers nearest the center of curvature. At the same time the neutral axis shifts from the gravity axis towards the center of curvature of the bar, as shown in Fig. 2. Distribution of this stress may be calculated from the commonly known curved bar theory, as given in books covering the subject.*

The usual method of calculating torsional springs is to apply ordinary beam theory, which is the same thing as assuming that the torsional spring is a straight bar under a bending moment. Actually however this is not true. Most torsional springs have a considerable amount of curvature and hence in calculation, if accurate results are to be had, it is necessary to use the more exact curved bar theory. This easily may be done by using the fundamental formulas for curved bars given in text books and applying them to the case of springs having given cross-sections.

*See for example *Applied Elasticity* by Timoshenko and Lessells, page 216.

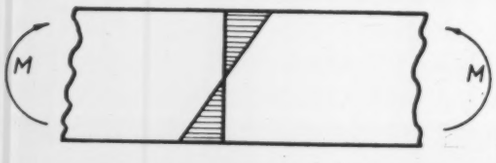


Fig. 1—Stress distribution in straight bar acted on by bending moment

Torsional Springs of Circular Cross-Section

For a more accurate calculation of the stress in torsional springs of circular cross-section we use the fundamental formula for maximum stress in a curved bar as derived from curved bar theory. This fundamental formula is:

$$S = \frac{Mh_1}{A\delta r_1} \qquad (1)$$

In this,

M = applied bending moment in inch-pounds.
h_1 = distance from neutral axis to innermost fibres in inches (Fig. 4).
h = depth of cross-section in inches.
A = area of cross section in square inches.
δ = shift of neutral axis from center of gravity in inches.
r_1 = inside radius of curvature of the bar in inches.
R = mean radius of curvature of the gravity axis of the bar in inches.

For a circular cross-section, the value of δ is:

$$\delta = R\,\frac{m}{1+m} \qquad (2)$$

In this, m is a constant which depends on the shape of the cross-section. In this case we may take $r_1 = R - d/2$ and $h_1 = d/2 - \delta$ where d is the wire diameter. Putting these values in Equation 1, we get for a circular cross-section:

$$S = \frac{M\left(\frac{d}{2} - \delta\right)}{A\delta\left(R - \frac{d}{2}\right)} \qquad (3)$$

Putting the value of δ given by (2) in (3) we

NUMEROUS comments received from readers indicate the interest taken in, and the value derived from, Mr. Wahl's series of articles, of which this is the last section. In it the author again shows that ordinary formulas, based on simple beam theory, are considerably in error for springs of small index.

find:

$$s = \frac{M\left(\frac{d}{2} - R\frac{m}{1+m}\right)}{AR\left(\frac{m}{1+m}\right)\left(R - \frac{d}{2}\right)}$$

If we take $2R/d = c =$ spring index or ratio of mean coil diameter to wire diameter, we may write this equation:

$$s = \frac{M}{Ad}\,\frac{2\left(\frac{1+\frac{1}{m}}{c} - 1\right)}{c-1} \qquad \text{.....(4)}$$

From the book *Applied Elasticity* the value of m for circular sections is given by the series:

$$m = \frac{1}{4}\left(\frac{1}{c}\right)^2 + \frac{1}{8}\left(\frac{1}{c}\right)^4 + \frac{5}{64}\left(\frac{1}{c}\right)^6 + \text{.....}$$

Since for practical springs c seldom is less than 3, this series converges rapidly. It was found to be sufficiently accurate to take two terms of the series, or:

$$m = \frac{1}{4}\left(\frac{1}{c}\right)^2 + \frac{1}{8}\left(\frac{1}{c}\right)^4$$

or

$$m = \frac{1}{4c^2}\left(1 + \frac{1}{2c^2}\right)$$

Since the last term in the brackets is small compared to unity, we may write this equation with sufficient accuracy:

$$m = \frac{1}{4c^2}\left(\frac{1}{1-\frac{1}{2c^2}}\right) = \frac{1}{4c^2-2}$$

or

$$\frac{1}{m} = 4c^2 - 2 \qquad \text{.....(5)}$$

Putting this equation in (4) and taking, for a circular cross-section, $A = \pi d^2/4$, we get for the maximum stress:

$$s = \frac{4M}{\pi d^3}\left(\frac{2}{c-1}\right)\left(\frac{4c^2-c-1}{c}\right)$$

This may be written:

$$s = \frac{32M}{\pi d^3}\left(\frac{4c^2-c-1}{4c(c-1)}\right) \qquad \text{.....(6)}$$

or

$$s = K_1\,\frac{32M}{\pi d^3} \qquad \text{.....(7)}$$

where

$$K_1 = \frac{4c^2-c-1}{4c(c-1)}$$

Since the section modulus of circular cross-section is $\pi d^3/32$, it is seen that this formula is merely the ordinary formula for stress:

$$\frac{32M}{\pi d^3} = \frac{M}{\text{Section modulus}}$$

multiplied by a factor K_1 greater than unity which depends on the spring index. For computation purposes, the curve of Fig. 3 has been plotted. From this curve it is easy to determine the stress multiplication factor for use in Equation 7. It may be seen that where the spring index is 3 for torsion springs of circular cross-section, the stress is about 33 per cent greater than that calculated from the ordinary formula.

Torsional Springs of Rectangular Section

In calculating torsional springs of rectangular wire we may proceed in the same manner as for torsional springs of circular wire. In this case, the value of h_1 (Equation 1) will be $t/2) - \delta$ where t is the thickness of the cross-section in the plane of the bending moment, and b is the width of the cross-section in a direction perpendicular to the plane of the bending moment. For such a case the section modulus is $b\,t^2/6$ and the stress from ordinary beam theory is $6\,M/b\,t^2$. We may show as follows from curved bar theory that this stress must be multiplied by a factor K_2 to get the true maximum stress. From Equation (1) taking $h_1 = (t/2) - \delta$ and $r_1 = R - (t/2)$ we have:

$$s = \frac{M\left(\frac{t}{2} - \delta\right)}{A\,\delta\left(R - \frac{t}{2}\right)}$$

In this case

$$\delta = R\,\frac{m}{1+m}$$

from Equation 2, and hence we have:

$$s = \frac{M\left(\frac{t}{2} - R\frac{m}{1+m}\right)}{AR\left(\frac{m}{1+m}\right)\left(R - \frac{t}{2}\right)}$$

Taking the spring index $= 2R/t$ we may write this equation:

$$s = \frac{M}{AT}\left(\frac{2}{c-1}\right)\left(\frac{1+\frac{1}{m}}{c} - 1\right) \qquad \text{.....(8)}$$

For a rectangular cross-section of depth t the

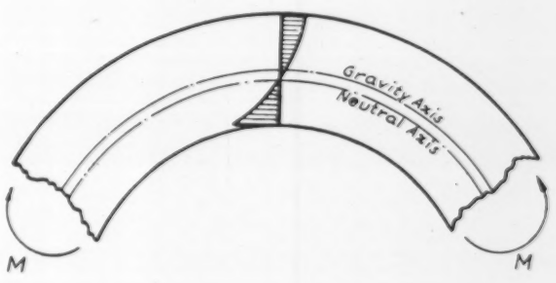


Fig. 2—Stress distribution in curved bar acted on by bending moment

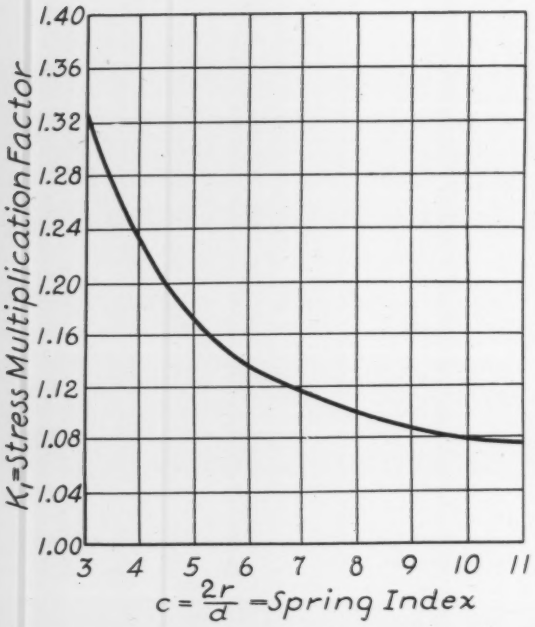


Fig. 3—Torsion spring stress multiplication factor K_1 for circular wire

value of m is given by the series:

$$m = \frac{1}{3}\left(\frac{1}{c}\right)^2 + \frac{1}{5}\left(\frac{1}{c}\right)^4 + \frac{1}{7}\left(\frac{1}{c}\right)^6 + \cdots\cdots$$

Again this is a rapidly convergent series for values of c greater than 3 and we will find that sufficient accuracy will be had by taking two terms of this series. Hence,

$$m = \frac{1}{3}\left(\frac{1}{c}\right)^2 + \frac{1}{5}\left(\frac{1}{c}\right)^4$$

or

$$m = \frac{1}{3c^2}\left(1 + \frac{.6}{c^2}\right)$$

Since $.6/c^2$ is small compared to unity for practical springs, we may write this with sufficient accuracy,

$$m = \frac{1}{3c^2}\left(\frac{1}{1 - \frac{.6}{c^2}}\right) = \frac{1}{3c^2 - 1.8}$$

or

$$\frac{1}{m} = 3c^2 - 1.8 \quad \cdots\cdots (9)$$

Putting this value of $1/m$ in Equation 8, we get

$$S = \frac{M}{At}\left(\frac{2}{c-1}\right)\left(\frac{3c^2 - .8 - c}{c}\right)$$

Since $A = bt$ we have finally:

$$S = \frac{6M}{bt^2}\left(\frac{3c^2 - c - .8}{3c(c-1)}\right) \quad \cdots\cdots (10)$$

This formula may be written:

$$S = K_2 \frac{6M}{bt^2} \quad \cdots\cdots (11)$$

where

$$K_2 = \frac{3c^2 - c - .8}{3c(c-1)}$$

It is seen that this again is the ordinary formula for stress in a bar of rectangular cross-section acted on by a bending moment M, i.e. $6M \div bt^2$ multiplied by a factor K_2 greater than unity and which may be taken from the curve of Fig. 5. In the case of a rectangular bar torsion spring with an index of 3, the correction factor K_2 from Fig. 5 is about 1.30. This means that the true stress for such cases is about 30 per cent greater than that figured by ordinary formulas. It is true, however, that the correction factor K_2 for rectangular wire does not deviate much from the factor K_1 for circular wire, as a comparison of Figs. 3 and 5 shows.

Deflection of Torsional Springs

Calculations made by the author for the deflection of curved bars indicate that for practical springs in deflection formulas commonly used for torsional springs (which are based on ordinary beam theory) are sufficiently accurate for most practical work. This is in line with the case of helical springs of round wire having small indices. While in such cases the true stress is much greater than that calculated by the ordinary stress formula, the true deflection is nearly the same as that calculated by the ordinary deflection formula. For this reason the ordinary deflectional formulas for torsional springs are probably close to the truth except insofar as other effects such as friction, etc. (which may depend on the particular method of mounting the springs, applying the load, or other factors) may enter.

A. M. WAHL is to be congratulated on his articles on the design of mechanical springs. After presenting a complete and fundamental theory of spring design, based upon results of modern research, practical modifications are introduced and sample design problems are worked out. In my estimation all articles treating the subject of design of machine parts should be presented in this way.—E. H. HAGEN.

Summing up the work covered by these articles, we have found that the commonly used

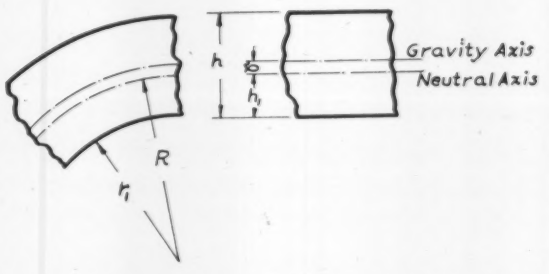


Fig. 4—Diagram showing symbols used in curved bar stress formula

formulas for stress and deflection in helical and torsional springs of round, square and rectangular wire are inaccurate in many cases. On the basis of recent research, more accurate formulas have been proposed for the use of practical de-

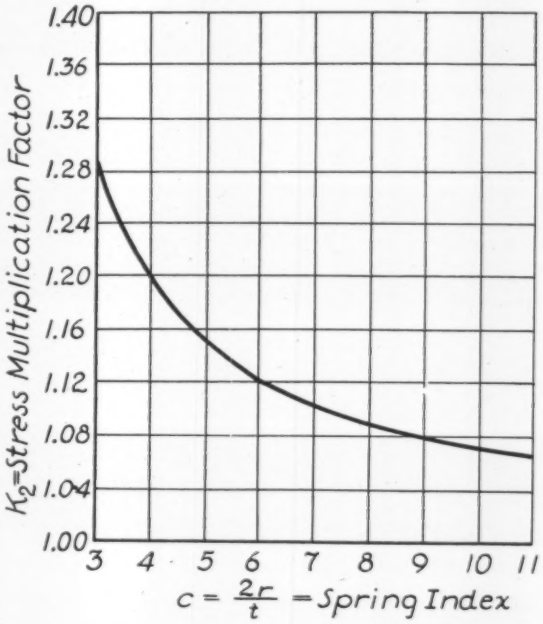


Fig. 5—Torsion spring test multiplication factor K_2 for rectangular wire

signers. Methods have been suggested and practical examples given whereby designers may correlate the actual stress and stress-ranges in springs of their design with the tensile and endurance properties of the spring material used. The effect on deflection and stress of small variations in the dimensions of helical springs has been shown to be considerable. The author hopes that the suggestions given in this series of articles may be of some value in assisting spring designers to put the design of this important element of our modern machines on a more rational basis.

Associated with the tremendous growth of the ice cream business and also the creamery butter industry the past 25 years, has been the increasing use of cream separators during this period. Although the first patents were taken on this machine 1878 there were some individuals and creameries opposed to its use even as late as 1905. Today the cream separator is counted as indispensable where butter fat is produced.

The greatest volume of mining and quarrying machinery in history was exported by the United States during the past year, according to the industrial machinery division, department of commerce. The total value reached was $17,953,877 as compared with $14,059,592 in 1928.

Processes in the Evolution of an Invention

By L. A. Trofimov, M.S.

SYSTEMATIC exploitation of inventive energy has begun. Industry now employs inventors to produce industrial inventions. There is no difference between these and ordinary inventors except that the work of the first is financed by an industrial concern, while the second are independent individuals. As far as the type of mind required to perform the work and the work itself are concerned, there is no distinction.

Contrary to the popular opinion that invention is beyond control, we have enough data from experience leading us to the conclusion that there is a natural process of growth and development of an industrial invention which offers the possibility of control. A necessary attribute of any invention is "a bright idea produced in a happy moment of inspiration." The two things—idea and inspiration—have been spreading a veil of mystery over invention and have kept it away from human control. However, an electron was more than a mystery some time ago, yet today we know exactly its dimen-

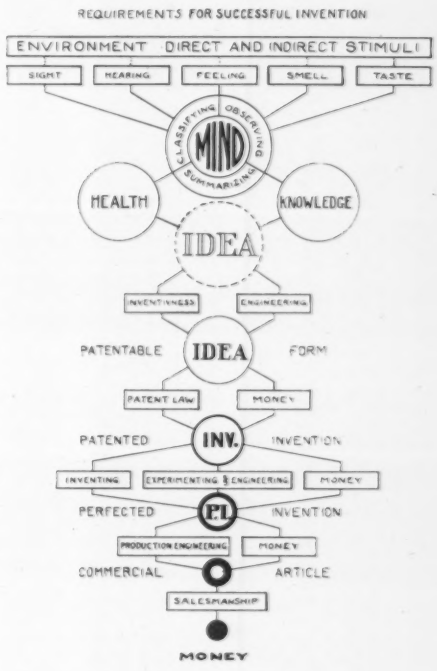


Chart showing various steps in inventing process

sions, behavior and properties. Constant observation and analysis of industrial inventing removed the veil and now something is known about the ideas which originate inventions, how they come to us, and under what conditions an

inspiration enters the mind of an inventor.

Building material for an idea is collected by the mind from the outside world and from the general environment of life; through the channels of the five senses it is carried and deposited in certain regions of the mind. The process of collecting is an ordinary work, consisting of observation and study and constant quest of a solution of the problem. There are three stages in the development of the idea: first, the collecting of material, second, the building and third, the transfer of the idea from the subconscious to the conscious mind. The process of building ordinarily is carried on by the mind in a subconscious way, the inventor being unaware of the process until some stimulus transfers the ready-made idea into consciousness. No stimulus however, can force the idea until the process of building is completed. In other words, time is a necessary element.

Environment Plays Its Part

It is possible to arrange the general environment in such a way as to favor the mind in this activity. Research, experimenting and study of the proper subjects will favor the collection of material; relaxation, recreation or change of subject will give opportunity to the mind to accomplish the building, and environment rich with stimuli will increase the probability of "hitting" the right stimulus for transfer of the idea. In the accompanying diagram it is shown that production of the idea is the beginning of making an industrial invention.

Inventive ability and engineering knowledge are required to reduce this vague conception to a state from which it can be described and sketched. At this stage of the development the idea assumes a patentable form. When by means of patent laws the patent is obtained it becomes an invention. However, most of the ideas produced by the industrial inventor are not patentable because they are not new to the world although these same ideas may be new to him.

The next stage is the perfecting of the invention, which means the development of it to a state when it is ready to be put into production. This is a hard task for the inventive ability and engineering knowledge of the inventor. Many times, while making a design, he has to employ his inventiveness to overcome hundreds of difficulties that are created by methods of production, selling points, standardization, engineering rules, physical laws, etc. During this stage of the development he makes many minor inventions which cannot be recognized. When the invention assumes the shape in which it can be put into production considerable expenditure is necessary for making tools. After this the sales organization must market and get money for the product, thus completing the evolution of the invention.

Designing Spindles for Extreme Speeds

(*Concluded from Page* 39)

and driving pins *FF* to maintain balance. The rear unit is assembled first and the completely assembled front unit carrying the coupling slipped into place over the keyed pilot *G*. Labyrinth sealing used at the pulley end and grooves, screwing out, keeps the dirt out at the wheel end bearings.

Fig. 11 illustrates a spindle used in Micro Machine company's planetary or eccentric head type of internal grinding machine for holes up to 48 inches in diameter and 84 inches deep. This shows a plain extension type of spindle for work 1¼-inch diameter, 6 inches deep. The spindle is made in two units. The front half, carrying the wheel, is mounted in sleeve *A*. This sleeve screws into an eccentric spindle housing (not shown) by thread *B*. Shaft *C* is mounted on four ball bearings which, with the sleeves and collars, are clamped by one left hand threaded nut *D* against shoulder *E*. Shaft *F* goes through the eccentric spindle housing and is mounted on ball bearings at the driving pulley end. The shafts are connected by a six-splined floating coupling *G*.

The feature of this complete spindle of sectional shaft design is in permitting a close spacing of the ball bearings to eliminate the possibility of vibration and insure smoothness of operation. Bearings are lubricated through holes *H* and *J* and a wire screen which strains the oil.

Combinations in Mechanisms

(*Concluded from Page* 43)

line. The tape is just wide enough to admit a maximum of five holes in a row, and there are five feelers each of which make electrical contact when it slips into a hole. There may be anywhere from one to five holes in the row in various combinations of position, each different combination representing a letter. Analyzing these combinations in the same manner as we did the linotype, we find a possibility of 31 combinations, all of which are utilized. One combination shifts the carriage to print figures and another shifts it back to print letters.

In general the designer will find combinations useful wherever he has to make selections among a large number of different factors, whether it be in a lock that will yield only to a certain combination of notches on a key, or a matrix that will drop only when a certain combination of ledges is cut away.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Any Power of Any Root of Any Number

To the Editor:

SEVERAL years ago I wrote an article on this subject which aroused considerable interest. But one letter I received contained this comment: "The writer has just seen your chart for extracting any root of any number. If you now will tell us how to do the same with fractions and how to keep track of the number of digits in any case whether expanding to a power or extracting a root, we will erect a monument in your honor." Whether or not this is a challenge, I do not know. If it is, I accept the challenge.

If engineers will take any slide rule and lay it end to end nine times and each time lay off the principal dividing lines they will have a chart exactly like the one shown in Fig. 1 excepting that it will be much longer and therefore much more accurate. By following this method they can make a chart that will go into the billions, trillions, or higher, as one limit; and a billionth, trillionth, or lower, as the other limit. To keep track of the digits you simply read the numbers exactly as they stand on the chart. No juggling of digits is necessary.

For example, what is the 5th root of 100,000? Measure the distance *A* from 1 to 100,000 as indicated on the chart. The distance *B* then must be exactly 1/5 of the distance *A* and there is the answer, namely, 10. In other words, divide the distance *A* by the root and the quotient shows the distance to measure from 1 to find the answer. Always measure from "1" in either direction. To extract the square, cube, or other root of fractions usually is more complex than extracting roots of whole numbers. However, with this chart one is just as easy as the other.

For example, to find the cube root of .008, measure the distance *C* from .008 to the starting point "1" and divide it by 3. Distance *D* gives the answer as 0.2.

A method that is as easy as any to find a third, fourth, fifth, etc. of any distance, is to use a pair of dividers. Adjust the dividers until you get the distance *D* exactly 1/3 of the distance *C* and the chart gives the answer without any mathematical calculations whatever. With this chart you can determine the 3.127 power for instance—any power in fact. And you can extract the 4.37 root or any other root, all without mathematics.

W. F. SCHAPHORST, M. E.,
Newark, N. J.

Is Standardization Sound?

To The Editor:

YOUR editorial in the July issue is an excellent and concise reply in the affirmative to this frequently raised question. I believe the major fallacy in the reasoning of many of the critics of standardization is that they do not take their stand on a particular detail standard until after that standard really has accomplished its initial purpose in aiding engineering development. Then, using as the basis of their criticism the production facilities and economies, as well as the design research and test

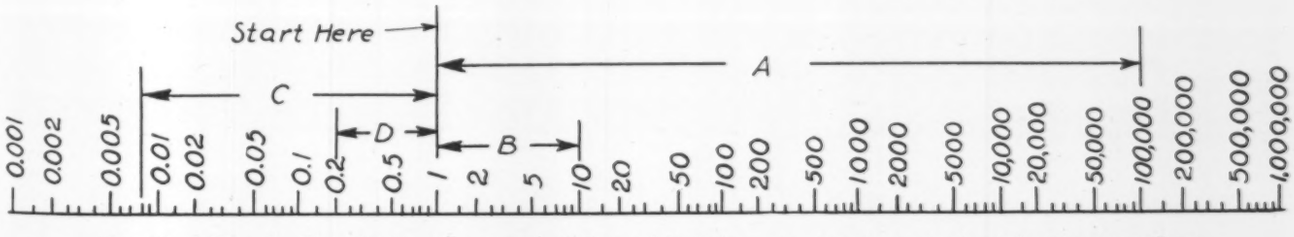


Fig. 1—Facsimile of chart proposed for obtaining powers or roots of any number

activity the particular standard has made possible, they condemn it because these very attributes now make possible departures and variations in large production applications which the standard itself has helped to create. Many a fabrication process development owes its impetus to a standardization activity which provided the volume necessary to warrant that development.

It will be of interest to consider a specific standard now being evolved by the Society of Automotive Engineers for aviation, and to examine the picture before as well as after standardization. Extruded duralumin structural shapes are of keen interest to the aeronautical designer. As the matter now stands, unrelated designs of extruded shapes have been from time to time specified and purchased by individual aircraft manufacturing concerns. Individual demand being relatively small in volume, the dies are made specially to order and generally are the property of the concern purchasing the shapes. Not only is this expensive and time-consuming in obtaining deliveries, but it results in special shapes few of which lend themselves ideally to any but the particular application for which they were evolved. With the rapid development of aircraft models, they in large part become obsolescent, since in general they are applicable to a particular function alone. Many times the designs are but reproductions by extrusion of shapes formerly manufactured by other methods, and do not take full advantage of the design possibilities inherent in the extrusion process itself.

Standards Assist Development

By the application of intensive design thought, it now is proposed to evolve a logical series of standards in the most useful shapes, taking full advantage of the basic possibilities in extruded design, conforming to the reasonable commercial possibilities at this stage of duralumin extrusion development, and offering a full range of sizes in the most usable proportions for aircraft. This not only opens the way for production for stock, but actually advances engineering development in that it incorporates in readily available form, the best current design taking all factors into consideration. As engineering and manufacturing technique advance, the standards simultaneously may be changed with them.

It likewise must be borne in mind that while it is necessary in some way to legislate a new standard in order to launch it, it never is necessary to legislate its abandonment should that become necessary. The moment it no longer is advantageous to them, individual users will drop it long before it officially is cancelled. So when viewed from the vantage point of the inception of a particular standard, it will be appreciated that rather than hamper development it really aids it.

—JOHN F. HARDECKER,
Philadelphia.

Suggests Change in Arc of Action

To the Editor:

I READ with a great deal of interest the article by Professor Martenis, "Gear Design —Strength of Teeth—Part 1" that appeared in April's MACHINE DESIGN. There is one thing I cannot agree with however, and that is: Fig. 1 and the statements pertaining thereto. The article states, "Referring to Fig. 1 it will be noted that the gear action begins at point *a* and continues to *b*. The arc of action is the arc of the pitch circle subtending the angle of action formed by the radii drawn from points *a* and *b* to the center of respective gears."

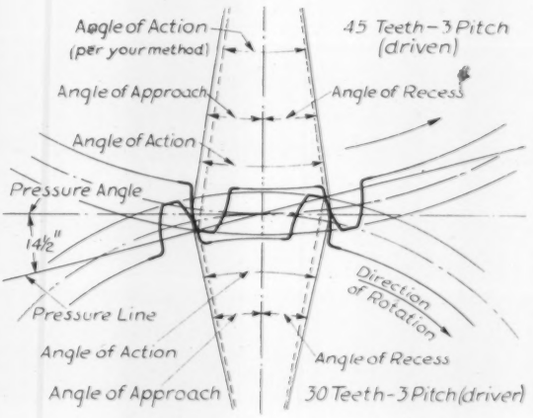


Fig. 2—Diagram showing angle of action discussed in original article and, in full lines, the suggested change

This I do not believe is the true angle of action and hence also not the correct arc of action. In Fig. 2 you will find a small layout of a pair of gears upon which I have shown what are to my mind the correct angles and arcs of action. According to my method the angles are slightly larger than those obtained by the method shown in original article. The usual definition for angle of action is: The angle the gear turns through while one of its teeth is in contact with its mating tooth on the other gear. The scheme I have indicated surely conforms to the definition.

I trust I have not taken too much liberty in

calling your attention to this apparent error and I hope the criticism is received in the same spirit of friendliness in which it is offered.

—JAMES I. CLOWDER, M. E.,
Chicago.

Cutting Costs on New Machines

To the Editor:

WHEN a machine is to be built for the first time, the manufacturer can avoid needless expense incident to unforeseen but necessary changes in design, by giving those who will handle the problem of manufacturing the product an opportunity to examine the drawings before the parts are made. Frequently the tool supervisor can suggest alterations which will permit the use of existing tools or fixtures, while the factory superintendent may bring out points which are likely to cause trouble in production. The men in charge of the forge shop, pattern shop and foundry also should look over the drawings with the view of avoiding difficulties in their departments. To save time, unchecked prints may be used which can be marked with comments and notations before being returned to the designer.

A designer with a stout eraser can remove more metal in a minute than a machinist can cut off in a day. Therefore the sensible and economical plan is to obtain the suggestions and opinions of all concerned and to incorporate the best ideas before a piece is made.

—GEORGE H. GUNN,
Philadelphia

Calculating Moment of Inertia

To the Editor:

I WAS glad to receive your recent letter concerning my comment on Prof. Flodin's article. It is a pleasure to have communication with men like Mr. Flodin and those on your staff who will accept a well intended comment in such an excellent spirit.

Today the July issue of your well-prepared monthly came to hand and it gives me further pleasure to see the supplementary article by Prof. Flodin covering so well the subject of rivet holes on the moment of inertia.

I intend to loan this issue to many of my friends in turn, so that they may get the benefit of Prof. Flodin's manuscript.

—F. W. SALMON,
Birmingham, Ala.

Pays Merited Homage To Late Designer

MACHINE DESIGN is privileged to reprint below an item which has appeared in the advertising pages of *Western Flying* and other leading aviation journals. It contains a merited tribute to a designer and signifies the recognition accorded a past member of its engineering staff by one of the leading motor car companies.

"Today, aviation and the engineering world pay tribute to the genius of one man—Captain Lionel M. Woolson. His creation—the Packard Diesel aircraft engine — is recognized as the most important contribution to aircraft power in a generation.

"It was with the spirit of the pioneer that Capt. Woolson set out to adapt the diesel principle to radial aircraft engines—to accomplish the "impossible." He believed that upon that principle could be designed a better, safer engine—the *ideal* power plant that aviation had awaited. The multitudinous problems concerned offered no barrier—and where others tried and failed, he and his staff signally succeeded.

"Like many another pioneer in aviation Capt. Woolson lost his life in an accident. His untimely death was due to no fault of the motor he designed—it performed perfectly.

"Packard lost its brilliant chief aeronautical engineer, but his work lives on. For Capt. Woolson was an able executive, as well as an engineer, and carried forward with the development of the aircraft-diesel the building of an organization of diesel specialists.

"The Packard-diesel is now in production and down through the years it will continue as a tribute to the pioneer who developed it — a living memorial to Capt. Lionel M. Woolson."

(Signed) ALVAN MACAULEY,
PRESIDENT—PACKARD MOTOR CAR CO.

Joins Standards Association

Manufacturers Standardization society of the valve and fittings industry just has become a member-body of the American Standards association, according to an announcement recently made by the association. The society now will be represented on the A. S. A. standards council and will share in the direction of national standardization activities.

The society has for some time been actively co-operating in the work on American Standards association projects, many of which have an important bearing on the valve and fittings industry. Forty-one companies manufacturing valves and fittings are members of the society.

Editorial

Preparedness Pays—Design Work Must Continue

ENGINEERS, in common with members of practically every other profession or trade, are subject to the effects of changing business conditions. Apparently no class is entirely immune from the vagaries of unadjusted economic forces. Yet in the present period, when thousands of officials in the production departments of industry have been discharged, laid off or placed on part-time employment, engineers engaged in design and development work in most cases have been kept busy. As a general statement, it may be said that they have fared better than their contemporaries in other lines of work.

While this is gratifying to members of the design profession, its real significance lies much deeper. Continued activity in the creation of new ideas and the development of new products and equipment is evidence of the new recognition by management of the importance of design. Not many years ago, it was considered good business to reduce design activities along with production. Today only a few companies have curtailed creative work, notwithstanding the fact that diminished orders have played havoc with income.

This changed attitude shows clearly that management now accepts the policy of preparedness in matters of design. With new materials being developed daily, and with processes and applications of old ideas being revamped frequently, it is not safe to let up on development work—even when business is at low ebb.

Thus is design gradually winning the recognition in high places which it merits.

For Reference Purposes

STRENGTH, in an engineering publication, is in exact proportion with the service the journal renders its readers. And that service is governed not only by general contents but by the ease with which it is possible to refer to specific items soon after, or months following, the initial reading.

Recognizing this, MACHINE DESIGN inaugurates a new feature with this issue. On page 7 will be found an index covering, item for item in the editorial and advertising pages, the design of contents of the journal. It fills a definite need and will assist readers in the filing of items or articles besides serving in its primary capacity as a reference.

This already has been confirmed through consultation with some of the leading engineers in the country. The index is unusual. In fact it is improbable that anything of the same nature, constituting as it does a continuous ready reference source, ever before has been attempted in publishing circles.

Mergenthaler and His Linotype Machine

Great Moments in Machine Design—Twelfth of a series of original drawings prepared exclusively for this magazine symbolizing the designer's contributions to the progress of mankind

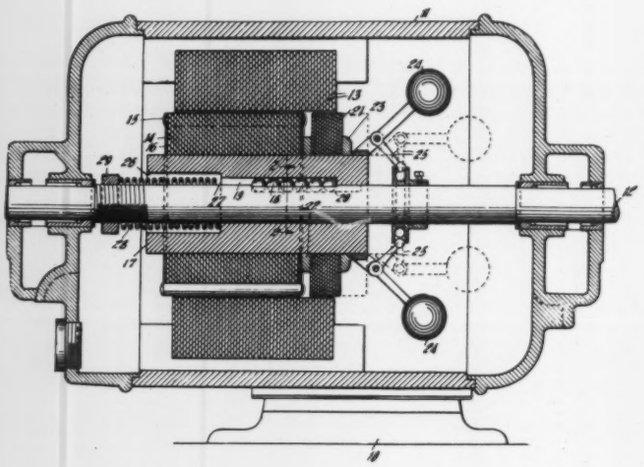
NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

SIGNIFICANT of the increased interest in the design of variable speed motors is the alternating current unit for which Wilfred Shurtleff, Moline, Ill., has been granted patent No. 1,763,104. This invention relates to improvements through which it automatically is governed to operate at any predetermined speed under variable loads. The Herman Nelson Corp., Moline, Ill., is assignee of the patent.

A minimum of current is required both at starting to eliminate flickering of lamps that may be on the same circuit, and while the motor is operating to avoid danger of overheating or burnout. In the accompanying illustrations Fig. 1 shows the improvements as adapted to a common type standard alternating current motor. The full line position of the parts shows the operative running condition and the dotted lines indicate the position of the parts when the motor is stationary.

Fig. 2 is a vertical sectional view corresponding to the section line 2-2 of Fig. 1, and illustrates the ball key connection for the rotor spider sleeve and shaft. This ball key is obtained by using a plurality of balls 18, which extend partially into a groove 19 formed in the sleeve 17 and partially into a groove 20 in the shaft 12. They do not occupy the full length of the keyway and therefore are free to roll back and forth when the sleeve 17 is shifted axially of the shaft.



A laminated inductance 21 axially separated from the rotor and aligned with the latter is employed. Washer 22 serves to separate the inductance from the rotor. By the shifting of sleeve 17 which carries the inductance 21, the latter can be moved to positions either entirely outside of the stator laminations or within the latter.

When the motor is stationary the spring 28 expands and forces the sleeve 17 carrying the rotor and inductance 21 to the right. After the speed increases, the governor arms and weights 24 lift outwardly, overcoming the pressure of spring 28, and shift the rotor and inductance 21 to the left. By adjusting nut 29 to vary the tension of spring 28 the axial shift of the rotor and inductance can be regulated to occur at any desired speed.

When the inductance is inserted between the poles of the stator, the inductance provides the easiest possible path for the magnetic flux from pole to pole. The inductance further acts as a "choke" to reduce the flow of current in the stator windings. In other words the inductance affords a "by-pass" for a portion of the magnetic flux and, to the extent of the amount of flux so by-passed, the conductors or windings of the rotor are not cut thereby.

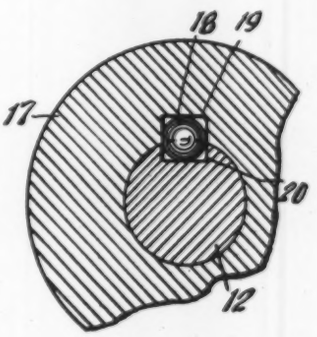


Fig. 1 (Left)—Sectional view of standard alternating current motor to which speed regulating device has been adapted. Full lines show position of parts when operating and dotted lines indicate stationary position. Fig. 2 — (Right) — Ball key connection for rotor spider sleeve and shaft. Balls are free to move back and forth when the sleeve is shifted

The more the inductance is inserted within the stator when starting the motor, the less will be the current input. Similarly, the greater extent to which the laminated inductance is moved within the stator pole space the lower will be the operating speed of the motor. Should the speed of the motor become less, the rotor and inductance thereupon will be moved slight-

ly to the right, lessening the amount of inductance within the stator pole space, bringing the speed of the rotor back to the predetermined amount for which the governor mechanism is set.

INCORPORATING an interesting principle, a servo mechanism invented by Henry W. Nieman, Bethlehem, Pa., has been granted patent No. 1,751,645. Bethlehem Steel Co. is named assignee. An object of the device is to provide a clutch mechanism for connecting and disconnecting a stationary shaft with a revolving

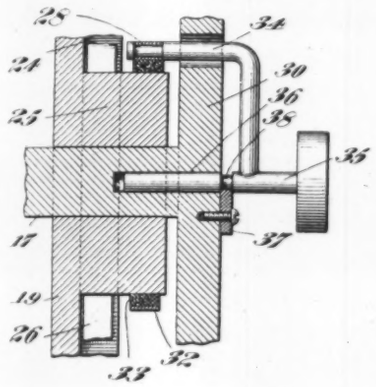


Fig. 1— Operator member for controlling operation of servo mechanism. By varying load on the second friction device direction of rotation of drive shaft is determined

shaft. This mechanism may be operated by a single device to transmit a driving force in either direction.

The servo unit has many mechanical applications and is particularly useful in the manipulation of some large body or object, such as a gun or searchlight where the work to be accomplished is more than can be delivered quickly and conveniently manually. It comprises generally a continuously operating power shaft geared to a pair of drum members mounted on a drive shaft which is driven by a power shaft. Drum members are adapted to be rotated continuously but in opposite directions.

In Fig. 2 a side elevation partly broken away illustrates an embodiment of the invention. Fig. 3 is a cross section taken on the line 11-11 of Fig. 2, and an enlarged section showing the operator member for controlling the movement of the mechanism is illustrated in Fig. 1. In operation the shaft 10 rotates continuously in one direction and by means of gearing operates the drums 18 and 19 in opposite directions. When the operator member 35 is turned in the direction of rotation of drum 19 the clutch band 32 will be tightened on the surface of boss 25. This causes the end 28′ of lever 28 to move to the right; owing to the tangential pull of band 32.

Characteristics of band type clutches the force exerted on the end of lever 28 will be several times that applied at the opposite end 34 of the band 32. This force will cause lever 28 to rock and the point 40 to move to the left, thus expanding the internal clutch band 26 causing it to grip drum 19.

As this takes place pressure is applied on pin 31 in the direction of motion of drum 19. This force is several times greater than that applied at the point 40 and consequently many times greater than the original force applied at 34. If the pressure on pin 31 is sufficient to overbalance that of the friction on disk 20, shaft 17 will turn in the direction of drum 19, whereas if it is less than this friction the shaft will turn in the direction of drum 18.

Although the drums operate in opposite directions, the control element and drive shaft will remain stationary until the controlling arrangement is manipulated. Control is extremely sensitive so that a very slight torque exerted on the device 35 will bring about synchronous movement of the drive shaft 17, though this shaft may be connected to some body or machine which opposes its movement with considerable force.

LUBRICANT retaining means are a feature of an antifriction bearing and mounting providing a simple device to take the thrust of a clutch operating mechanism. The invention was conceived by Frederick G. Hughes, Bristol, Conn., who has been granted patent No. 1,762,-819. New Departure Mfg. Co., Bristol, is assignee.

One of the clutch controlling members 16, shown in the illustration on page 56, is normally pressed by clutch spring 18 against the outer race 20, while the flange 12 engages an inner race ring 22. The outer race ring has a central ball groove 24 and the inner race ring has a complemental ball groove 26, the grooves

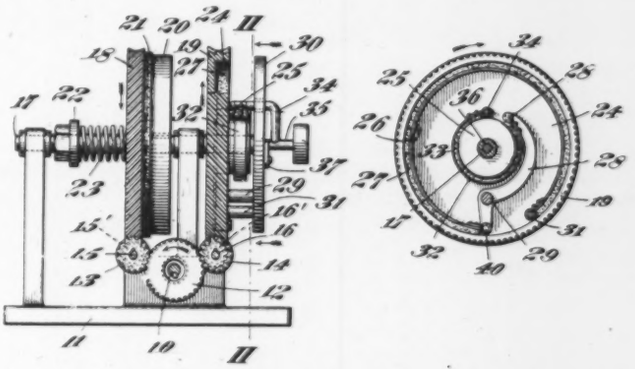
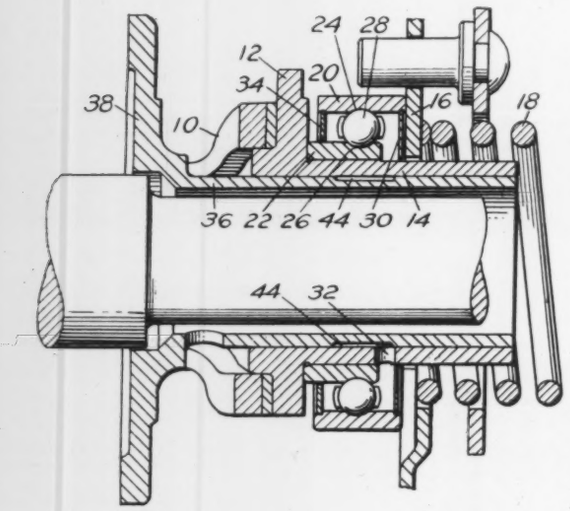


Fig. 2—(Left)—Side elevation of mechanism. Shaft 10 through gearing rotates drums 18 and 19 in opposite directions. Fig. 3—(Right)—Cross section of drum showing internal clutch band

confronting one another radially and being engaged by a series of balls 28 to hold the race members against axial movement in either direction.

The outer bearing ring rotates while the inner ring does not. One end of the latter projects

beyond the outer ring to take the thrust from flange 12. The other end terminates short of the outer race ring which transmits the thrust to clutch control member 16. A lubricant retaining member, a flat washer 30, is secured to the projecting portion of the outer race ring,



Central section of antifriction bearing and mounting which takes the thrust of a clutch operating mechanism and provides a lubricating means

at a point removed from the ball grove. It extends across the end of the inner race ring to admit the lubricant from the opening 32 in the sleeve.

Sleeve 14 has a radial extension bored to permit injection of lubricant from a grease gun. Lubricant is conducted to a longitudinal groove or duct in the member 36, which communicates with an annular groove or duct 44, and the latter duct provides communication to the opening 32 in the sleeve 14. It also lubricates the sleeve for sliding movement.

Washers 30 and 24 first are dished or coned and then pressed out flat to engage undercut recesses in the outer race ring. An inclined face of slightly larger diameter than the dished washer leads up to the undercut recess and guides the washer to a seat. Thereafter the flattening of the washer expands it into the recess. The designer of the device also has included modified form of the invention. He sets forth that one of the objects of the arrangement is "to provide a simple device of this character to take the thrust of clutch operating mechanism or the like with provision for conducting lubricant to the bearing surfaces."

APPLICATION of a new idea in the design of a grease cup is illustrated in patent No. 1,759,211 which recently was granted to Hugh B. Spencer, Duluth and William R. Smith, Winnipeg, Man. The invention relates to plug controlled grease cups, the primary object being to provide fine adjustment.

Fig. 1 is a combination side elevation and sectional view of the completely assembled plug. Fig. 2 is a top plan view and Fig. 3 a fragmental portion showing modified forms of spring catches. The cylindrical body portion of the plug is of two different external diameters, the upper part 5 being less than that indicated by 4. Grease is contained in the chamber 13 which has a threaded hole formed in the upper end, communicating with the chamber 15 and closed by threaded plug 16.

Pitman 17 having a head 18 is installed within the cylindrical body of the plug. Helical spring 20′ normally keeps the pitman in its lowermost position in which it is held in fixed relation to the cap and crown 12. When the cap is rotated in an anticlockwise direction or backwardly, in respect to the notches of the parts 4 and 8, the cap together with the pitman will be raised. This contracts the helical spring 20′ until one complete step of the notch co-operative portions has been accomplished. Spring 20′ serves to keep the section 8 from being removed entirely and functions in re-registering the notched portions of the two parts of the body of the plug.

A spiral spring 29 is provided as motive power for the feeding portion of the plug which is carried by part 8. This spring imparts action to the feeding element 4, and screwing it into the grease reservoir in clockwise direction. Grease thereby is forced into the bearing.

When it becomes desirable to unscrew the parts 4 and 8 from the base of the plug in order to replenish lubricant, etc. the staple vertical key 21 is depressed into one of the recesses 25. One leg 22 of the key is longer than 23. The leg 22 is made to pass through the path of key 20 and to avoid engagement therewith is

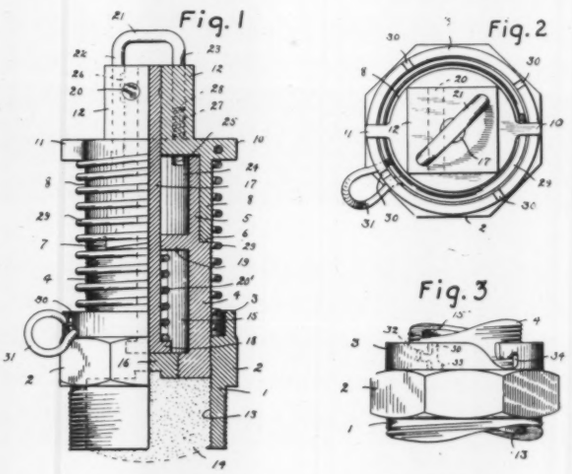


Fig. 1—Combination side elevation and sectional view of completely assembled plug. Fig. 2—Top plan view of plug showing key lock. Fig. 3—Modified form of spring catches

provided with a vertically elongated notch 26 formed in the side thereof next the key 20. When the latter key is in position in the crown of the cap it acts as a keeper for key 21 but does not interfere with its vertical adjustment in engaging or disengaging the body portion 5. Simultaneously with the application of a wrench on the crown 12 the key 21 is depressed. If the cylinder is not too tight it may be turned out of the plug by hand which such depression of key 21.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

CHANGE SPEED DEVICE—1,766,414. Covered by this patent is a change speed device, "the combination of a shaft having an internal gear thereon; a second shaft having an external gear thereon; a lay shaft having an external and internal gear thereon meshing with the aforesaid internal and external gear, respectively; a casing, a bearing in the casing for the lay shaft; a movable eccentric sleeve in said bearing and means for moving said eccentric sleeve, said means being accessible from outside the casing." Assigned to Morse Chain Co., Ithaca, N. Y.

ROLLER BEARING CAGE—1,765,648. This patent covers a roller bearing cage "consisting of a one-piece cage ring having spaced rectangular openings extending radially there through, bearing rollers rotable in said openings and each opening having portions of its opposite side walls extending in substantially parallel relation to each other to the inner face of the cage ring. Other portions of the walls converge inwardly toward each other to the outer face of the ring on arcs, the radii of which are greater than the periphery of the rollers. Assigned to Norma-Hoffmann Bearings Corp., Stanford, Conn.

INTERNAL COMBUSTION ENGINE — 1,765,713. Comprising this invention is a reciprocating piston engine having a plurality of cylinders arranged radially about the drive shaft and pistons adapted to reciprocate in the cylinders. A main driving cam is secured to the shaft and rotationally actuated by the thrust of the pistons. Further cam means have a peripheral contour dissimilar to that of the main cam and a plurality of elements have a rolling contact with said means. Linkages are adapted to constrain the pistons against lateral displacements. Assigned to Aeromarine Plane & Motor Co. Inc., New York.

CONTINUOUS TREAD TRUCK—1,765,739. Comprising this patent covering a continuous tread truck is a power means carried by a turntable, an axially disposed vertical shaft connected with the power devices, a pair of continuous treads and power connections between the vertical shaft and the treads. A pair of clutches connect a rotatable transverse member with the treads and a slotted link connected to the rock arms, extends into overlapping position adjacent to the wheel. The wheel carries a pin which engages the links. Selective operation of the rock arms is effected by movement of the wheel in opposite directions. Assigned to Ohio Power Shovel Co., Lima, O.

Facts About Safety Devices for Machines

(*Concluded from Page* 42)

draulically operated. To one coming from the ordinary boiler shop with the clang of gears (cut with ¼-inch backlash), and the bang of clutches, this shop almost would be noiseless.

"Suddenly things changed. The hydraulically operated mechanism was pulled out and geared shears and punches took their place. Gone was that quietness and ease of operation. No longer could the shear blade be teased along to a line and stopped. The new machine must make its full cycle of operation and the blade complete its full quota of travel. This added much to the operator's work. The noise also affected his nerves until he became crabby.

"Look at the machine shop of today with its automatic and semi-automatic machinery. Designed, of course, for production but at the same time for ease of operation, which means ease for the operator. Remember the old-time lathe with the spindle revolving at 200 revolutions per minute slowly eating away the metal on a part with the operator standing up along the machine, sometimes not touching it for two or three hours. The foreman would not let him sit down so he stood up and slowly became stoop-shouldered. Some few firms have added chairs to the equipment of those old machines, but it has been at the instance of the younger generation. Standing around doing nothing is harder on the men than work would be. Nothing will wear out a man as fast as inactivity, especially in a place where noise is dominant.

"Noise, it would seem, is the great magnifier of fatigue. One is more nearly fagged out after a day's work in the shop full of old-fashioned machinery than in a shop equipped with small automatic machinery, so nearly noiseless. The electric motor has done much to reduce noise and fatigue. Another great item has been the advancement in gear manufacture. It was not so long ago that gears were cut with a possible 1 /16-inch variation in center distance and for a gear 36 inches in pitch diameter, I pitch, the variation ran up to ¼-inch. These gears were of necessity noisy. All this has changed. Gears are cut to plus or minus .001 in center distance with the result that machines are quiet if kept in repair.

"Mr. Peterson's studies in street railway gears, as referred to in an early article on this subject, are not quite appliable to the machine shop under modern conditions. The street car is of the old order of manufacture with gears cut inaccurately. Finer pitches, while they increase the natural frequency of vibration, are not nearly so noisy as was the old coarse pitch with its ¼-inch backlash.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

BEGINNING Aug. 1, William States Lee assumed the duties of president of the American Institute of Electrical Engineers. His election took place at the recent annual summer convention at Toronto, Ont. Mr. Lee is a native of Lancaster, S. C., and studied at The Citadel, a military college in South Carolina. In 1929 he received the honorary degree of doctor of science from Davidson college in North Carolina. He has been a pioneer in high voltage hydroelectric power development and transmission and is the inventor of the Lee Pin. Among his numerous affiliations and activities he is president of the W. S. Lee Engineering Corp., Charlotte, N. C.

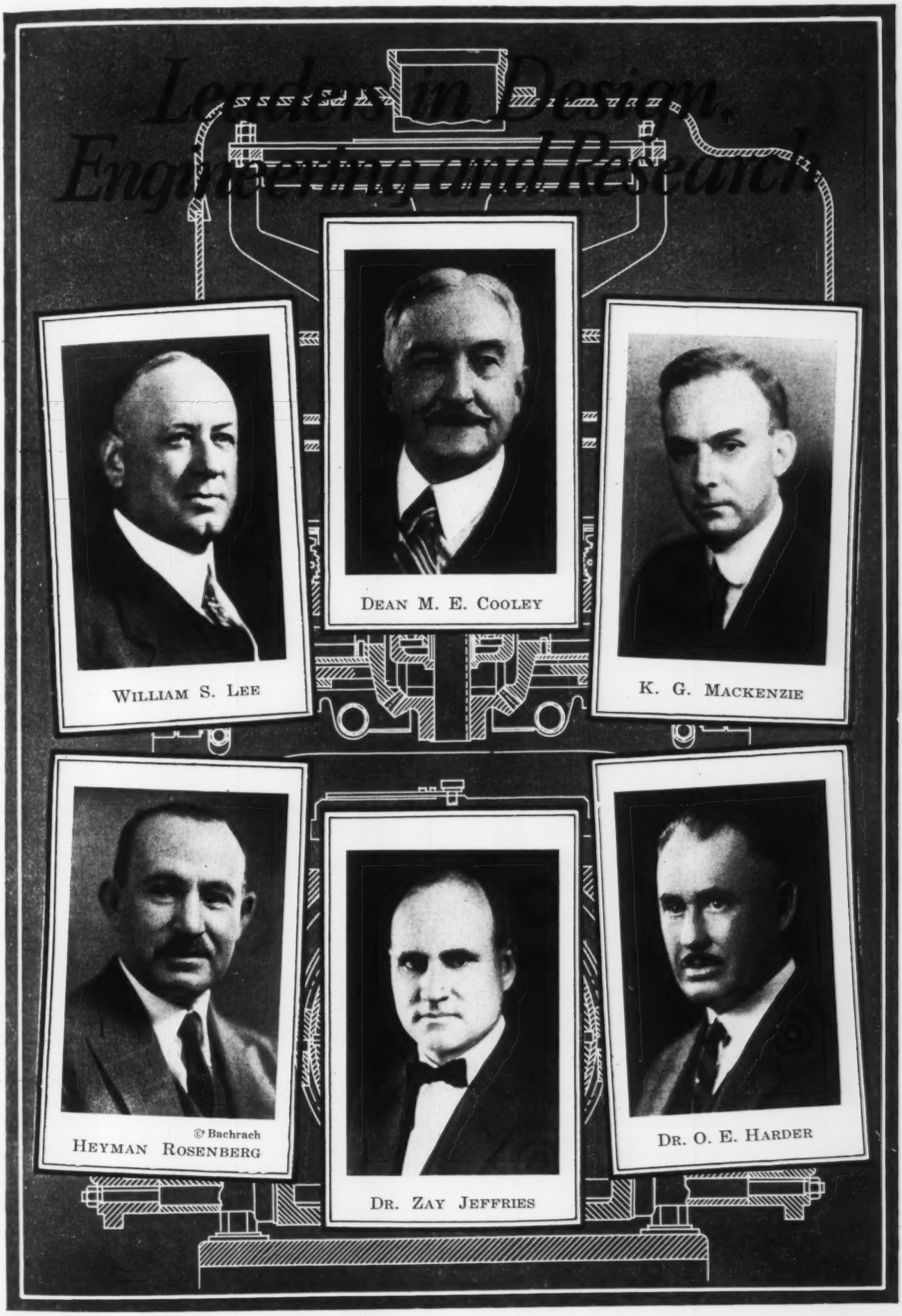
HONORARY membership in the Franklin institute was presented to Dean Mortimer Elwyn Cooley, dean emeritus of the college of engineering, University of Michigan, at the recent annual medal meeting of the institute. The honor was conferred in recognition of services to his profession. For over 20 years Dean Cooley was professor of mechanical engineering and during that time was responsible for the courses in machine design. Born March 28, 1855, on a farm near Canandaigua, New York, he received his early education in the district school near his home. In 1878 he was graduated from Annapolis naval academy and in the summer of 1881 was detailed to the university of Michigan as professor of mechanical engineering. His record at the university is a remarkable one, and in addition he has been called upon by the industrial world to solve many problems including some in machine design. Besides his work in an educational capacity he has been active in many technical societies and he holds several honorary degrees.

AT the recent annual meeting of the American Society for Testing Materials, Kenneth Gerard Mackenzie, Texaco Co., New York, was elected president. Feb. 4, 1887 was the date of his birth in New York and in 1907 he received the degree of bachelor of philosophy at Yale university. The master of science degree was conferred upon him in 1909. Since 1911 Mr. Mackenzie has been a consulting chemist with the Texaco Co. From 1925 to 1927 he was a member of the executive committee of the American Society for Testing Materials and vice president from 1928 to 1930. In addition to his membership in this society he is affiliated with a number of other technical organizations.

FOR his development of hardened, self-tapping screws, Heyman Rosenberg, vice president of Parker-Kalon Corp., New York, was awarded a certificate of merit by the Franklin institute at a meeting held recently in Philadelphia. His first invention along this line was a self-tapping sheet metal screw and later he devised and patented a hardened metallic drive screw. Existing need for a similar device which could be used in heavy gages of sheet metal led Mr. Rosenberg to pursue his experiments. The result was an improved form of his original self-tapping sheet metal screw. His latest achievement is the screwnail.

THE election of Dr. Zay Jeffries as a member of the executive committee of the American Society for Testing Materials, bespeaks additional honor for him in the engineering profession. Through his technical activities and associations as a consulting metallurgist with a number of industrial organizations he is known as one of the outstanding figures in this field. For the past 13 years he has been devoting his attentions largely to research for the Aluminum Co. of America. Dr. Jeffries was born at Willow Lake, S. Dak., April 22, 1888, and was graduated from the South Dakota State School of Mines in 1910 with a bachelor of science in mining engineering degree. In 1914 he received the degree of metallurgical engineer and in 1918 Harvard university conferred the degree of doctor of science upon him. He was a member of the faculty of Case School of Applied Science, Cleveland, and is affiliated with a number of engineering societies.

WITH the appointment of Dr. O. E. Harder as assistant director of Battelle Memorial institute, Columbus, O., the staff of this organization acquires a man of wide reputation in his field. He comes from the University of Minne-


Leaders in Design, Engineering and Research
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HEYMAN ROSENBERG
DR. ZAY JEFFRIES
DR. O. E. HARDER

sota where he was in charge of metallography. Dr. Harder is a specialist in physical metallurgy, heat treatment and allied subjects and has on occasion done research work on materials to be used in machines and the heat treatment to be employed for the different materials. Dr. Harder will devote part of his time to the work being conducted at the institute by the alloys of iron committee of the Engineering Foundation.

* * *

C. E. Johansson, inventor of the Johansson gaging system and head of the Johansson division, Ford Motor Co., Detroit, has been knighted by King Gustav of Sweden in the Royal Order of the North Star. Mr. Johansson perfected his invention in 1896, a precision measuring system in use in practically every large automobile plant. He was born in Sweden and plans to return as soon as business conditions permit in order to receive his knighthood.

* * *

Frank Dustan of the engineering department of Putnam Machine Works of Manning, Maxwell & Moore, Inc., New York, has been appointed chief engineer. He became connected with Manning, Maxwell & Moore Inc. in 1919 as a designer and later became assistant chief draftsman and then sales engineer, specializing in railroad and steel mill machinery.

* * *

E. R. Godfrey, formerly superintendent of the generator plant of the Delco-Remy Corp., Anderson, Ind., has been appointed vice president in charge of production of the Frigidaire Corp., Dayton, O. In 1913 he was employed in the tool design department of the Remy Electric Co.

* * *

Albert G. Zima, until recently identified with Western Crucible Steel Castings Co., Minneapolis, as metallurgical engineer, is now associated with the development and research department of the International Nickel Co. Inc., New York.

* * *

John A. C. Warner, who has been with the Studebaker Corp., South Bend, Ind., since November, 1926, has returned to the Society of Automotive Engineers, having been appointed secretary and general manager to succeed the late Coker F. Clarkson. C. B. Veal has been appointed his assistant. Born in 1893 at Putnam, Conn., Mr. Warner was graduated from the Worcester Polytechnic Institute in 1917 with the degree of Bachelor of Science in Mechanical Engineering and during the World war completed an officers' course in aircraft and engine design at the Ecole Superieure d'Aeronautique et de Construction Mecanique in Paris. He has a distinguished record of engineering service in the American expeditionary forces in France and Great Britain, as an engineering officer in charge of numerous projects of the air service technical section.

* * *

John Chucan has resigned as chief engineer with the Mercury Mfg. Co., Chicago, and is traveling in Europe.

* * *

W. A. Wood, formerly research engineer in the dynamic section of Buick Motor Co., Flint, Mich., recently was appointed research engineer of Handy Governor Corp., Detroit.

* * *

Petrus A. Carlson has been appointed designing engineer with the Sikorsky Aviation Corp., of Stratford, Conn. His previous connection was as chief engineer of the Commercial Aircraft Co. of America, at Bridgeport, Conn.

* * *

J. A. Callahan, formerly vice president and general manager of Martin Parry Corp., and later manager of the Buffalo plant of Curtiss Wright Corp., has become associated with Briggs Mfg. Co., Detroit, in charge of new development.

* * *

O. C. Steinert, formerly chief engineer of Pittsburgh Steel Co., Pittsburgh, has become affiliated with the engineering department of Blaw-Knox Co., Blawnox, Pa. He will devote his time largely to the development of steel plant equipment.

* * *

Walter T. Fishleigh has opened consulting engineering offices at 2265 Longfellow avenue, Detroit. He was engineer with the Ford Motor Co. from 1919 to 1930, the last six years as executive engineer in the Ford engineering laboratories.

* * *

Edwin Jay Prindle, chairman of the patents committee of the American Engineering council, New York, has been accorded the honorary degree of doctor of laws by National university, Washington.

* * *

C. B. Veal, the newly appointed assistant general manager of the society of Automotive Engineers was graduated from Purdue university in 1902 with a degree of bachelor of science in mechanical engineering. For 15 years following his graduation Mr. Veal was retained at Purdue university in various capacities, includ-

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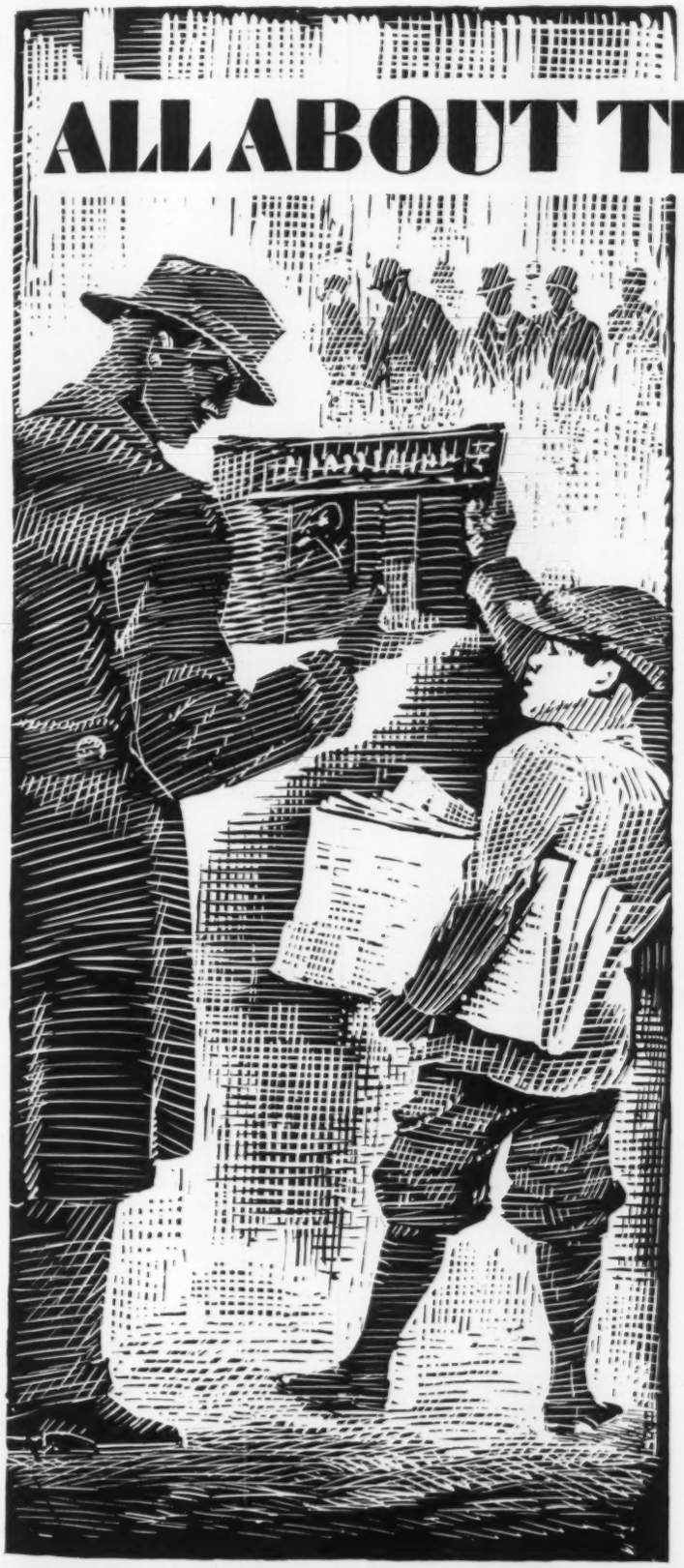


ALL ABOUT THE BIG FIRE

THAT shrewd little merchant on the street corner—purveyor of the world's news, thought and opinion—is an important cog in the machinery of civilization.

Because of his untiring service we know within the hour the world's great happenings that affect our lives and fortunes. Because of his persistent salesmanship great batteries of giant presses all over the world keep turning ceaselessly.

These thundering presses, grinding out their millions of impressions every day, maintain their marvelous efficiency through the use of Cold Finished Steel Bars in their construction. From this material in all shapes—round, square, flat, hexagonal, or special drawn—are made the shafts, rods, bolts, screws, keys, pawls, grippers, collars, rollers and hundreds of other parts.

For lasting durability that will withstand the strain and wear of high speed and severe uninterrupted service—in printing presses and other complicated, fast moving machinery — *no other material takes the place of Columbia Cold Finished Steel Bars.*

Columbia Steel & Shafting Co.
Pittsburgh, Pa.

COLUMBIA
COLD FINISHED BARS AND SHAFTING

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

WHILE much new mechanical design is emanating from the automotive industry, progress also is being made in many other fields. Eight cylinder power plants for automobiles are becoming the vogue and Studebaker has introduced a free wheel device. The advent of the Austin "Bantam" car brings a diminutive vehicle into the field.

In the airplane industry innovations likewise are appearing. Caproni Co., an Italian aircraft builder, recently completed what is claimed to be the largest airplane built since 1918. It is equipped with six 1000 horsepower Isotta-Fraschini engines and is said to be able to take off with a good load of 15 tons.

Among the new developments in the textile world is a double-deck silk and rayon twister in which is incorporated a transverse mechanism of new design, with self-lubricating cam and roller. Each deck is driven by an individual motor.

Designed to register a drawbar pull up to 250,000 pounds and withstand a buffing shock of 1,250,000 pounds, a new all-steel dynamometer car recently was built by the Chicago, Milwaukee & Pacific railroad.

* * *

Diesels Discussed At Power Convention

Interesting discussion and comment on diesel engines and their design were evoked by papers on various phases of the subject at the third national meeting of the Oil and Gas Power division of the American Society of Mechanical Engineers at State College, Pa., recently. A survey of the more important research problems investigated in the laboratory maintained by the National Advisory Committee for Aeronautics at Langley field was given by Carlton Kemper. Spray nozzel design was discussed by P. H. Schweitzer, associate professor at Pennsylvania State College.

Exhibits were more numerous and elaborate than in previous years and attendance exceeded 280. Two diesel automotive vehicles were driven to the convention in time for the meetings. They were the Robert Bosch diesel truck and the diesel passenger car designed and built by C. L. Cummins. C. A. Lorenzen, inventor of the combined gas turbine and turbo blower which bears his name, was among the speakers. Another was G. J. Dashefsky of the engineering staff of the New York navy yard, who presented a paper summarizing the most important facts pertaining to control of torsional vibrations and containing practical engineering recommendations.

* * *

Subject of Memorial Lecture Announced

The subject, "Oxygen in Steel," has been selected for the 1930 Campbell Memorial lecture. It will be delivered by Dr. Marcus A. Grossmann, Republic Steel Corp., Canton, O., at the annual meeting of the American Society for Steel Treating, Stevens hotel, Chicago, Sept. 22-26.

Dr. Grossmann is well known in fields of research metallurgy, and has presented a number of technical papers before meetings of the society. He is chief metallurgical engineer, Republic Steel Corp.

* * *

A. S. A. Approves Ball Bearing Standards

Proposed standards for annular ball bearings of the single row type, light, medium and heavy series, and for ball and roller bearings of the wide type, have been approved by the American Standards association as American standard and American recommended practice, respectively. This action followed approval by Society of Automotive Engineers and the American Society of Mechanical Engineers, the sponsors.

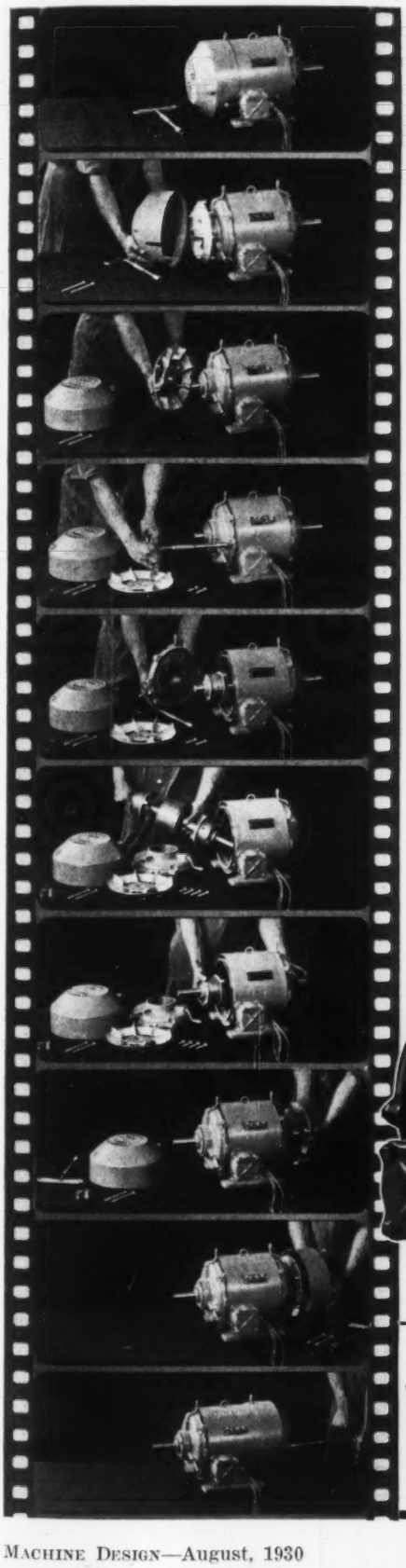
Standardization of ball bearings was undertaken in 1919, the committee co-operating extensively with foreign standardizing bodies in an effort to achieve international unity on this point. Two international conferences were held and differences between foreign and American practices were practically eliminated in 1928 and 1929. The standard for annual ball bearings was approved by the sectional committee in 1928.

* * *

To Depict Evolution of Machine Age

An evolutionary story of the "machine age" will be unfolded by a special educational exhibit to be held by the Museum of Peaceful Arts in its new headquarters at 220 East Forty-second street, New York, Sept. 12 to Nov. 15. According to the announcement the display will

Only 4½ Minutes to take apart and reassemble



this NEW

type J **TOTALLY ENCLOSED FAN-COOLED MOTOR**

THIS "movie" illustrates the remarkable ease of taking apart a Louis Allis type J . . . the *improved* totally-enclosed fan-cooled motor.

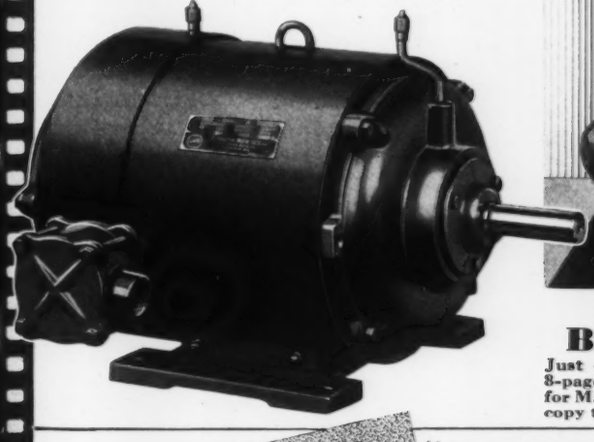
Starting with a motor assembled standard, Mr. Average Maintenance Man is shown changing the rotor end for end, to bring the conduit box on the opposite side for convenience in wiring . . . as often required when installing motors from stock, or moving motors from one location to another.

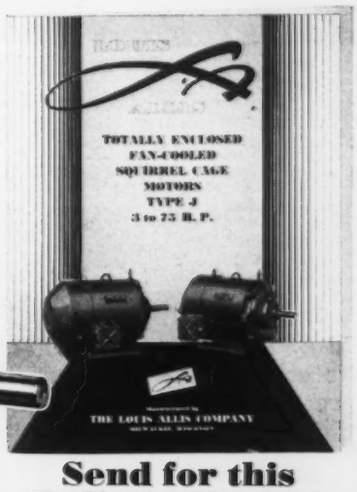
Only 4½ minutes were required to make this change and reassemble the motors . . . by virtue of the "cartridge type" bearing chambers and simple devices for quickly removing the fan, ventilating shell and heads. And in another test under ordinary conditions, only 2 minutes additional time was required to open the cartridges and inspect both ball bearings.

MAINTENANCE ENGINEERS of the process and automotive industries "wrote the specifications" for type J motors when they requested Louis Allis engineers to develop a motor that would be "tightly sealed, but *easy to take apart*." The "tight seal" consists of all *solid* enclosing parts joined by *long close* metal-to-metal fits . . . and provides complete protection when motors are operated in atmospheres of abrasive or combustible dust, corrosive fumes, moisture, etc. . . . as *proved* by a severe 8-day continuous test.

Machines that you build cost less to install and maintain in dusty, corrosive, and moist atmospheres . . . are insured against service interruptions . . . and are *more saleable*, when equipped with L.A. type J motors.

TYPE "J" *Patents Pending*





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Just off the press. An interesting 8-page bulletin. An instructive manual for Maintenance Men. Write for your copy today.

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THE LOUIS ALLIS COMPANY
MILWAUKEE, WIS.

Motor Specialists for 29 Years *Offices in Principal Cities*

present the scientific discoveries, inventions and machine improvements over a period of 15 decades.

Included among the contributing American companies, numbering nearly 100, are many machine tool builders. The work of assembling the exhibit has been in progress for more than five months. Photographs, models, statistical data, diagrams and examples of work of modern artists on mechanical and industrial themes will supplement the actual machines, many of which will be in operation. Power will be depicted as the central force. It is planned to divide the exhibit into three periods.

* * *

Steel Treaters Announce New Publications

Two new publications, the 1930 *National Metal Handbook* which has been revised and expanded, and a monthly periodical, *Metal Progress,* have been announced by the American Society for Steel Treating. The handbook is being distributed and members of the society may receive copies by sending their old handbooks to J. Edward Donnellan, Cleveland. Copies are available to non-members at $10 for the initial volume and $5 for new editions, providing the previous issue is returned. *Metal Progress* is scheduled to appear Sept. 1. Ernest E. Thum, for three years associate editor of *Iron Age,* has been appointed editorial director.

* * *

Systematic Lubrication Aids Performance

Adoption of pressure grease system of lubrication for locomotives similar to that used on automobiles is dispensing entirely with the use of the engineer's oil can and has made possible increased speed and longer runs. This interesting point was brought out in the report of the committee on lubrication at the recent eleventh annual convention of the mechanical division of the American Railway association.

* * *

Sees Passing of the Individual Inventor

Individual inventors will be unknown in the future and "Edison may be the last of the great heroes of invention." This is the opinion expressed by Waldemar Kaempffert, director of the Museum of Science and Industry, Chicago, in his reading course, *Invention and Society* recently published by the American Library association. The places of these "wizards" are being taken by groups in elaborately equipped industrial research laboratories, with which the individual cannot compete.

The passing of the individual inventor is not viewed as a blow to production of new designs by Mr. Kaempffert. Instead he believes that the result will be more inventions, and problems will be solved that hopelessly baffle the lone inventor. The industrial laboratory and "group" invention have telescoped time, he says, and further reading of the lives and achievements of the great inventors is recommended in his course. The author was engaged in editorial work with a number of noteworthy publications before becoming director of the museum.

* * *

Claim Russia Is Out to Copy Machinery

Design of American machinery evidently appeals to the Soviet judging by the opinions of two mechanical engineers who recently returned from Russia. According to these two representatives of an American farm machinery company the Soviet have little use for American machinery except to copy from it.

Both engineers, sent there to give instructions in the use of equipment produced by their firms, found the situation in Russia very unsatisfactory and returned to this country ahead of schedule. Co-operation was lacking, they said, and peasants and Soviet officials alike did not appear interested. "We could plainly see that the officials wanted to know technical names and details so they could duplicate our machinery in the huge plant that is being erected 10 miles from Nijninovgorod."

* * *

Creep Tests of 29 Alloys Are Studied

Results of creep tests at different temperatures for 29 different alloys are given in the July issue of the bureau of standards of *Journal of Research.* The metals tested are representative alloys of iron with varying proportions of nickel, chromium, tungsten, vanadium and molybdenum in the rolled, forged or cast condition. Some of the material was heat treated following the mechanical working.

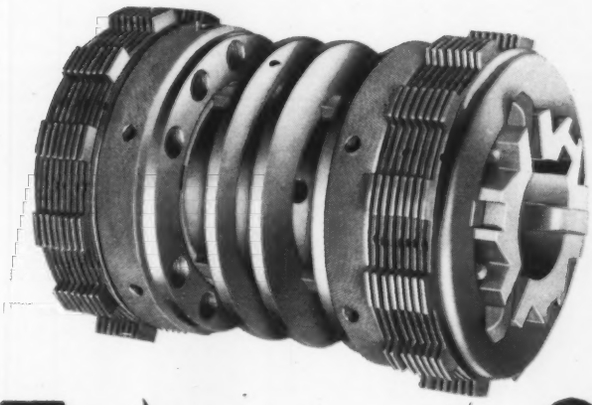
The chemical compositions of most of the materials are such as are used in the fabrication of heavy equipment for oil refineries, power plants, chemical plants and for the extrusion of metals. Charts are given to permit the approximate determination of such stresses as will permit the metals to last for definite periods with specific amounts of deformation.

* * *

Research Building Under Construction

Construction of an engineering and research building has been placed under way by the A. O. Smith Corp., Milwaukee, manufacturer of steel products. The building, which is seven stories high, is to be given over to the development, engineering and research activities of the corporation.

In this new addition to the properties of the corporation, the human element will be supreme and the mind will completely replace the machine. Starting with an idea instead of a pattern or a piece of metal, the events will take place logically and scientifically.



Model CC
Twin Disc
Duplex Clutch

START . . . . . STOP . .

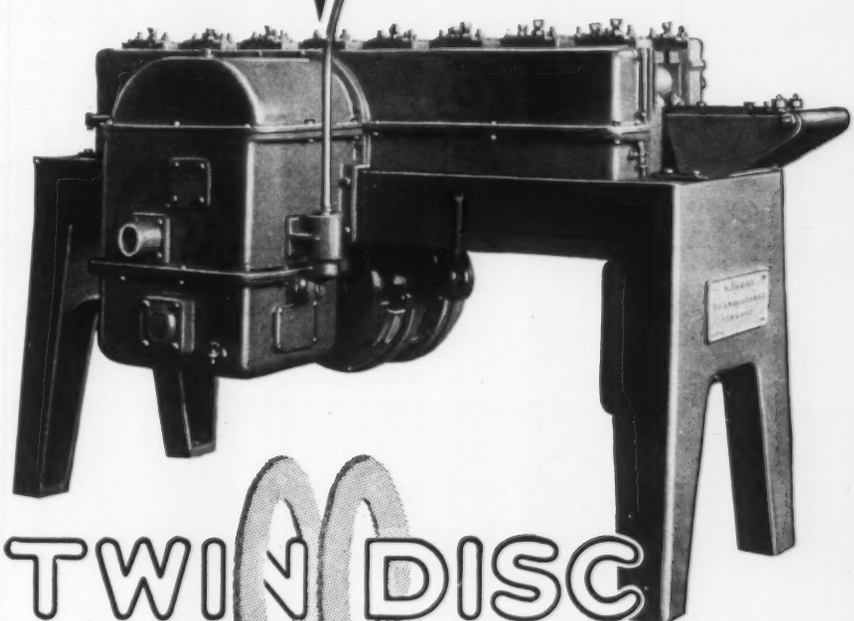
AND TWO SPEEDS AT THE TOUCH OF A FINGER . . .

Here's a machine that forms angles, channels, mouldings, tubing, etc. from flat metal at a speed of 125 to 200 feet per minute . . . the Type 1-B Roller Die Forming Machine built by The McKinney Tool and Mfg. Co., Cleveland, Ohio.

Such production speed demands perfect control. McKinney engineers built it in . . . with the new "CC" Twin Disc duplex action clutch, which is standard equipment on this machine.

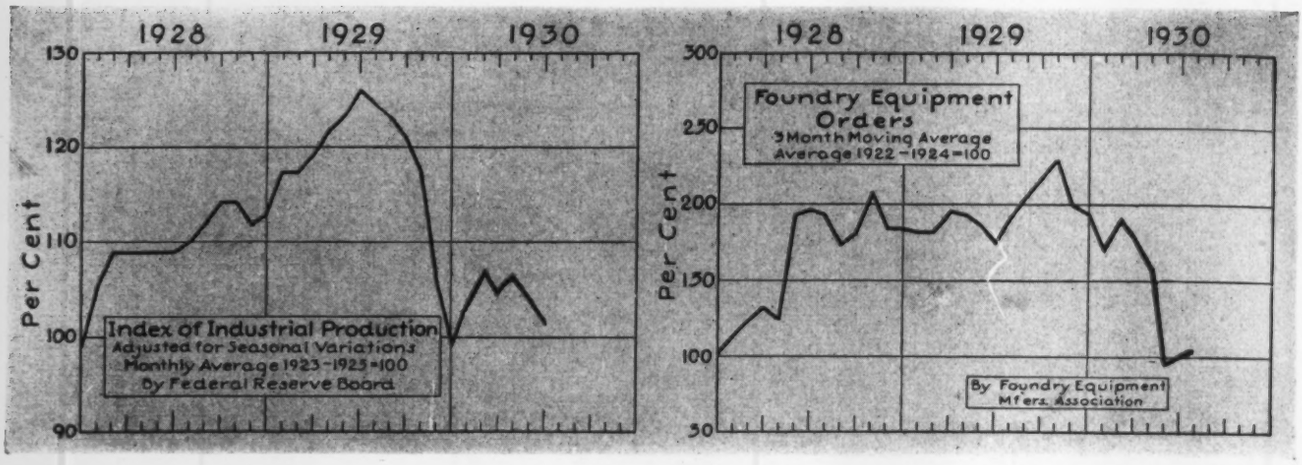
Remarkably compact . . . with unusually large capacity for size the "CC" Twin Disc clutch engages and releases smoothly, without objectionable dragging. The hub contains all the operating mechanism . . . centrifugal force operates to release pressure levers. Oil spray gives all lubrication necessary. The few adjustments necessary are easily made.

Machine designers appreciate the greater adaptability of the "CC" Twin Disc Clutch. It is purposely designed to meet conditions of engineering modern, high capacity machine tools. Sizes: 2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 7 and 9 inches effective diameters; single or duplex, oil or dry plate, types. Write for Engineering Data Book or consult our Engineering Research Dep't. for specific recommendations. *Twin Disc Clutch Company, Racine, Wisconsin.*



Back View of Type 1-B Roller Die Forming Machine . . . Twin Disc Clutches built in gear box

TWIN DISC
CLUTCHES

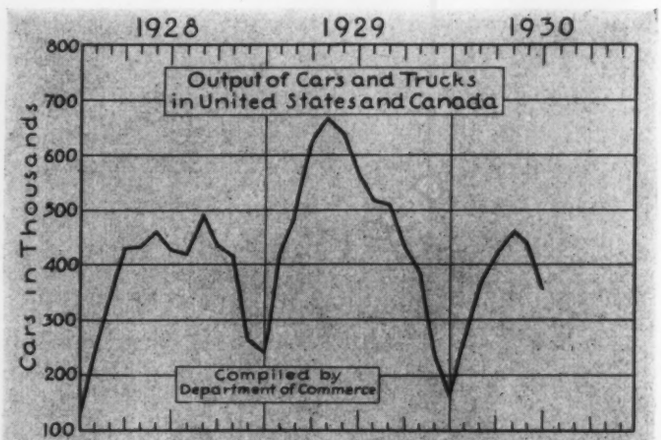


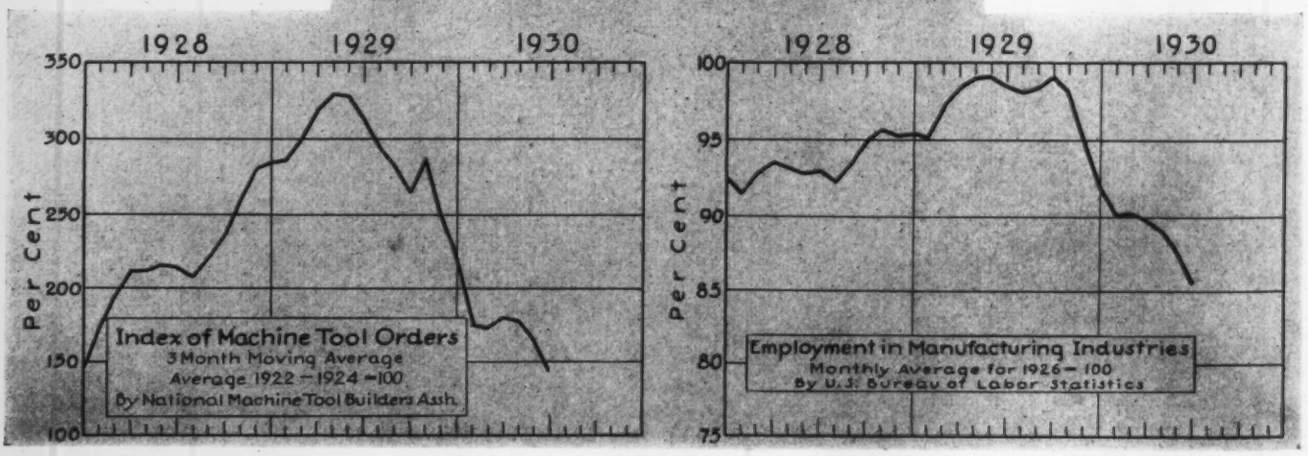
How Is Business?

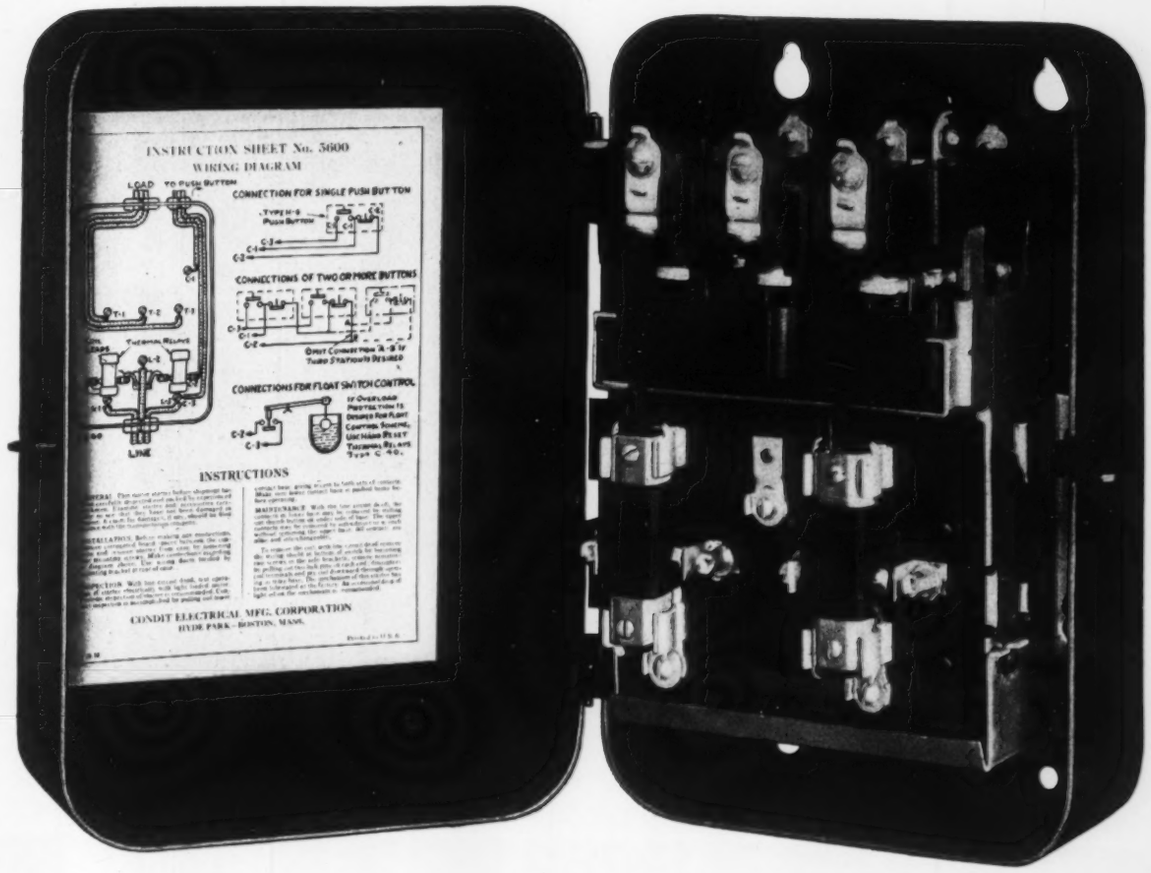
WHILE better business is forecast, present conditions continue to flounder in a depressed state. The usual summer slump is a contributing factor. Statistical records, however, bear a hint that gives the situation a brighter tone. Low money rates continue and the resulting favorable influence on business is beginning to be noticeable.

Autumn still is predicted as the turning point. Demand is slow and in the absence of active buying manufacturers have curtailed production. Suspended operations during recent weeks are the result of this in many cases. Raw material stocks in the hands of consumers are low and this is seen as a good indication for resumed buying in the near future. Signs of a buying movement are developing in the nonferrous metal industry. Last report of the index of machine tool orders disclosed that bookings of both smaller and larger companies showed an increase. Foundry equipment orders for June also were heavier than in May. Supplementing this favorable report, builders of certain types of heavy equipment have enjoyed fair business.

Eastern builders of textile machines report that they are taking a few orders but demand is spotty. Employment for June showed further decline due in a large measure to a 40 per cent cut in labor ranks in some industries. Commodity prices still tend downward. Nonferrous metal prices are firmer. *Steel's* composite of 14 steel and iron products has declined slightly from July's average.







IT ISN'T YOUR FAULT

FLASH!!!
The old way

if the motor starter goes wrong. But when it does, your product, of which it is a part, gets blamed. Therefore the Condit A-30 air motor starter offers double protection—it protects the circuit and it protects you. By the application of a new principle, it deals with the arc before it is formed, preventing it before it occurs. With the A-30, there is hardly an arc—only a spark. Compact, sturdy, beautifully made, easy to install and remarkably durable on account of its novel principle of operation, the A-30 offers you a real value in a real starter—a starter that will wear well and work well with anything you put it on, with perfect safety all the time. The A-30 is approved by Underwriters' Laboratories and Associated Factory Mutual Insurance Companies. Write for the details now—they are of genuine interest to you and usefulness to your product.

HARDLY A SPARK
The Condit way

"Get in touch with Condit"

CONDIT ELECTRICAL MFG. CORPORATION

Manufacturers of Electrical Protective Devices

BOSTON, MASS.

CONDIT

NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Motor Has High Starting Torque

DESIGNED for use wherever explosive vapors are encountered, an improved type of explosion resisting motor has been introduced by Master Electric Co., Dayton, O. Applications include gasoline pumps, spray booths, dry cleaning plants, gas plants and service in the manufacture of paints and varnish.

In the design of this new motor are such features as high starting torque and overload capacity, cool running and quiet operation, vertical or horizontal mounting and liberal thrust bearings for vertical types. Built under the supervision of the National Board of Fire Underwriters, every motor shipped carries a regular underwriter's name plate indicating that it has been built under maximum supervision. The interchangeable frames used permit single phase, polyphase, and direct current motors of the same horsepower, speed and current rating to be installed on the same mounting. This feature means a saving in pattern costs as well as in mounting time and labor, and eliminates the necessity of having a special mounting for each different type of motor.

Improved type of explosion resisting motor adaptable to vertical or horizontal mounting. Liberal thrust bearings for vertical types also are a feature

The new unit is compact and attractively designed and can be purchased in sizes from ⅛ to 1/3 horsepower inclusive. Master Electric company offers the services of their engineers to design these motors to any particular application. Whenever necessary the motor will be "custom built" to meet the special requirements of the application.

Accuracy Feature of Lubricators

MECHANICAL lubricators in five different types for industrial applications have been announced by Nathan Mfg. Co. 250 Park avenue, New York. Ease and accuracy of regulating the quantity of lubricant delivered are features along with positive operation and simple mechanical construction.

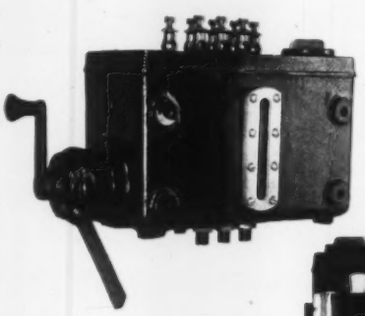


Fig. 2—(Below)—Type DS1 lubricator has drip sight feed, ratchet or rotary drive and piston mechanism

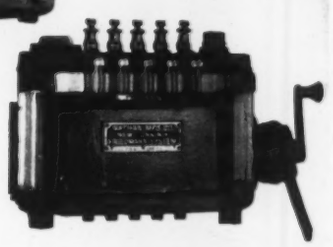


Fig. 1—(above)—Type D mechanical lubricator showing visible piston indicator

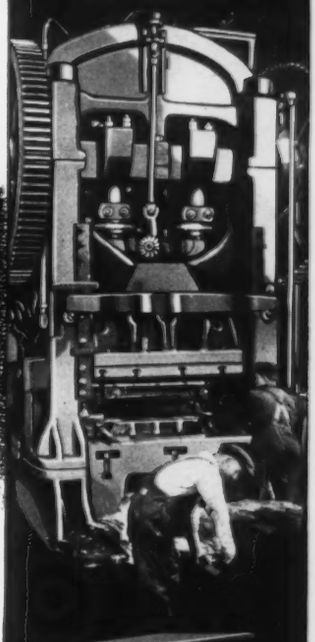
One of the types designated D is shown in Fig. 1 and has a capacity ranging from 1 to 38 feeds. The ratchet drive may be on either right or left hand side as desired. For reversible engines the lubricator can be furnished for both directions of rotation. Visible piston indicators eliminate the necessity of using a sight feed instrument. The unit is recommended for machine tools, presses and all applications where an attendant is not present to check the amount of lubricant being delivered.

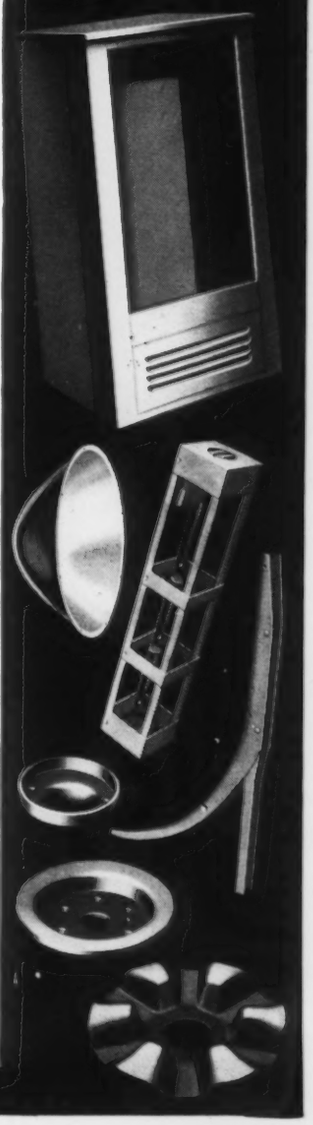
Sight feed lubricator known as type DS1 shown in Fig. 2 has the feeds arranged to permit the instrument to work against pressure without subjecting this pressure to the sight feed glasses. It is recommended only for cylinder lubrication.

Similar in mechanical construction to type D but smaller and more compact, Type PK shown

Minutes Mean Profits

Truscon facilities are sufficiently diversified to handle any Pressed Steel Problem





TRUSCON

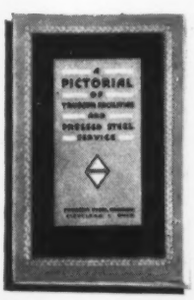
PRESSED STEEL

Cuts Needless Labor from Manufacturing Costs ▲ ▲

HERE, in one of the world's foremost, diversified pressed steel plants, presses . . . both gigantic and small . . . are turning out products in minutes that formerly took hours of expensive labor to produce.

Let Truscon Pressed Steel Redesign Engineers do for you what they have for others. Let them study your catalogues and parts list with a view of redesigning your products in pressed steel. They may find that impressive savings in labor, weight, material costs, machining and assembling can be achieved.

Send us your catalogues and parts lists for examination. This unique Truscon Service is yours without obligation.



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Pressed Steel Division
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Get the facts of Saving with Truscon Pressed Steel. This brochure is yours for the asking.

PRESSED TRUSCON & DRAWN STEEL

SAVE WITH PRESSED STEEL

in Fig. 4 is adaptable to small machine tools and other small equipment. Type PS shown in Fig. 3 is the same as PK but has less oil reservoir capacity. It may be employed for built-in construction on equipment having an oil reservoir to eliminate oil and grease cups in remote

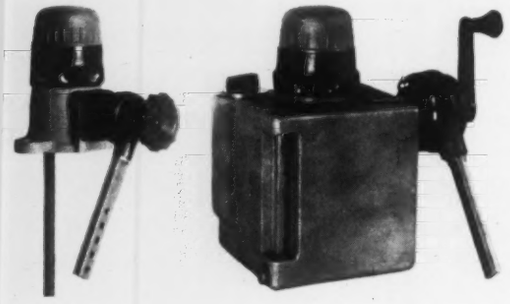


Fig. 3—(Left)—Type PS has simple piston mechanism, and is without oil reservoir. Fig. 4—(Right)—Type PK is similar to Type D

places. Type P which is not shown is provided with a connection for attachment to an oil reservoir already on the machine but not located in a convenient place for the driving of the lubricator.

New Felt-Seal Bearing Announced

RADICAL improvement marks a new type of patented felt-seal bearing recently developed by S K F Industries, Inc., New York. A felt seal is provided as an integral part of the bearing, thus making it necessary for the machine manufacturer to provide only one housing enclosure.

Cross section of felt-seal bearing showing constructional details

Outer and inner races as well as the balls are made of high carbon chrome alloy steel hardened throughout. Bore and outside diameter are ground to international standard dimensions and tolerances, the same as the corresponding standard single row bearings. The width however, is slightly greater than the standard dimensions of a single row bearing in order to accommodate the felt seal. Tolerances on eccentricity of the outer and inner races also are international standard tolerances for single row ball bearings.

The seal consists of an inner steel plate which is dished at its periphery and bears against a shoulder formed on the outer race. A removable felt of substantial size comes next, then a dished steel end plate, after which a split steel ring is fitted into a groove in the outer race to hold the assembly in place.

An outstanding feature of the design is the ease with which the seal may be disassembled at any time and new felts applied. The bearing is available in sizes that are applicable to a wide range of small mechanical equipment, such as fractional horsepower and small motors, portable tools, and other light equipment.

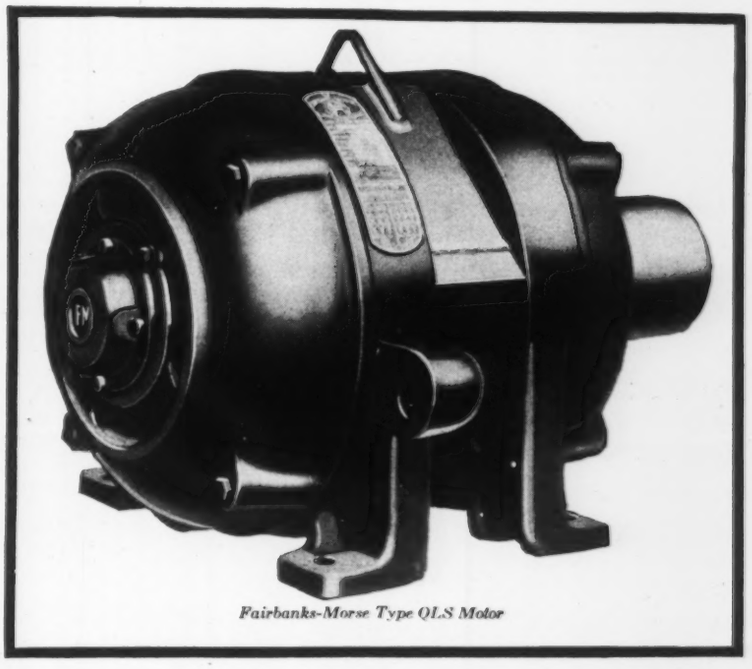
Introduces Standard Stock Drives

ANNOUNCEMENT of its new stock drives for all standard power applications has been made by Diamond Chain & Mfg. Co., Indianapolis. The Diamond stock drive consists of a roller chain and two sprockets, ready to be installed. They are carried in stock by distributors and supply-houses in all leading centers in single to quadruple strands, from ¼ to 75 horsepower, in ratios up to 8.4 to 1 and for motor speeds up to 1750 revolutions per minute. Diamond stock drives make the advantage of roller chain and sprockets more readily available where no special design-problems are encountered. They supplement the regular line of high speed drives which handle up to 672 horsepower and speeds up to 3600 revolutions per minute.

Multiple speed drive available from stock for standard power applications

Starting Switch Is Small in Size

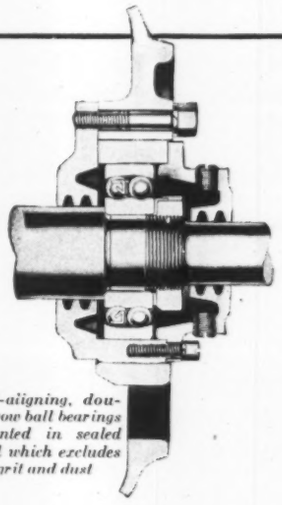
FOR convenient starting and stopping of small direct current and polyphase motors, Cutler-Hammer Inc., Milwaukee, offers a new bulletin 9103 two pole, push-button operated starting switch with thermal overload relays. This new starting switch can be used with direct current motors up to ½ horsepower, 115 volts and ¼ horsepower, 230 volts or with alternating current motors, single, two or three phase up to 2 horsepower, 110 to 550 volts. Small in size, the enclosing case is a standard wiring box. The switch can be mounted on the machine, at the



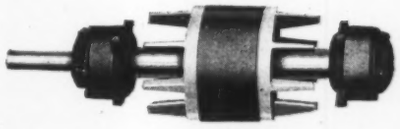
Fairbanks-Morse Type QLS Motor

See how

F-M Motors will help sell *your* machines



Self-aligning, double-row ball bearings mounted in sealed shell which excludes grit and dust



Complete rotor showing sturdy shaft and large, completely sealed ball bearings

IF you build motor driven machines—let the motor be a real selling factor. Fairbanks-Morse Type QLS (line start) Motors offer exclusive advantages that will attract buyers and make friends.

For instance, supposing you told a prospective buyer of your product that the motor (an F-M Type QLS) needed greasing *but once a year*. Would he be interested? He would. And you could tell him more—much more.

The bearings, for example—self-aligning, double-row ball bearings—are mounted in *sealed shells* which are absolutely dust tight. They stay clean *always* as the rotor may be removed without exposing them. Wear is practically eliminated. Mechanical losses are reduced. Electrical efficiency is high at full and partial loads. Motor life is greatly increased. Operating costs are reduced to a minimum.

There are other features—important features—about Fairbanks-Morse Type QLS Motors. These features will interest you because they can be made a selling factor for *your* machines. Complete details will be mailed promptly upon request.

FAIRBANKS-MORSE & CO.

900 S. Wabash Ave., Chicago

32 branches at your service throughout the United States

1930
begins the
SECOND CENTURY
of building
FAIRBANKS SCALES

FAIRBANKS-MORSE MOTORS

EA40.32

operator's finger tips. For machinery builders, an open type switch for building directly into the machine, is offered.

Double-break, silver contacts and a quick break contact mechanism assure long life and continuous current carrying capacity. Thermal overload relays allow working the motor to the limit, yet disconnect it as soon as an overload becomes dangerous to the motor. When tripped by an overload, simply pushing the "reset" button resets the relay and starts the motor. The enclosed switch has conduit knockout holes in the top and bottom for easy wiring. Arrangements are provided for sealing the cover if desired.

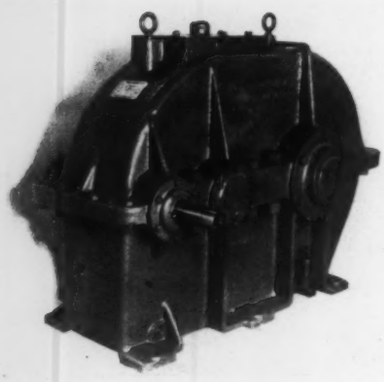
Two-pole push button operated starting switch provided with arrangements for sealing the cover

Designs New Type Speed Reducers

TYPES SH and DH speed reducers are new Westinghouse-Nuttall standard single and double-reduction units for use in general industrial and mining operations. They are of the non-planetary design with shafts arranged in a horizontal plane, and have either right or left-hand assembly as desired.

Both types are made in twelve sizes providing a total of twenty-eight standard reduction ratios ranging from 2.82:1 to 70.5:1 and having capacities of 1 to 635 horsepower.

In type SH units efficiency at full load is from 98 to 99 per cent and in type DH units 96 to 98 per cent. These speed reducers are conservatively rated on the basis of torque to be transmitted in continuous service, with ample allowance for 100 per cent overloads occurring at starting and momentarily during operation.



Lubrication is supplied by the splash system. Type DH-18 speed reducer is shown opposite

Coupling Designed for Special Use

ECONOMY on special applications is one of the purposes of type "E" flexible coupling recently announced by Ajax Flexible Coupling Co., Westfield, New York. It is of the pin and rubber bushing type and is a modification of the standard Ajax type "A." Type "E" is a special coupling of limited size, designed for special equipment, such as centrifugal pumps, small speed reducers, fans, motor generator sets, and in fact all applications at motor speeds within the bore and load limitations of the coupling.

It is made with aluminum alloy flanges, hardened and ground alloy steel drive studs and compounded rubber bushings firmly cemented to hard bronze bearings by a new Ajax process. Weight is only 2 pounds per coupling, due to the use of the aluminum flanges. It is made in one size only, suitable for loads up to 7½ horsepower at 1750 revolutions per minute. This particular coupling has dimensions as follows: 4-inch outside diameter by 2 1/16 inches overall length, 1½-inch maximum bore with shallow keyways. The coupling is noiseless, free from vibration, easy to assemble, allows no backlash and provides free end float.

Flexible coupling made in one size only and equipped with aluminum alloy flanges

Starter Armature Is Direct Acting

A NEW 2300 volt, full voltage magnetic starter, is being built by The Electric Controller & Mfg. Co., Cleveland. This starter,

STANDARDIZE on STANDARDIZED

DIETZGEN

DRAFTING AND SURVEYING SUPPLIES

YOUR confidence (and the confidence of thousands of others like yourself) in DIETZGEN has imposed a tremendous obligation—an obligation to give you "enduring worth at reasonable cost," to give you always the Prompt Service that you have come to know as characteristic of DIETZGEN.

How well DIETZGEN fulfills its obligation is attested to by the fact that Standardized DIETZGEN Drafting and Surveying Supplies are the acknowledged "Standard" of the Industry.

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Enduring worth at reasonable cost

Chicago New York Philadelphia Washington
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San Francisco *Factory at Chicago*

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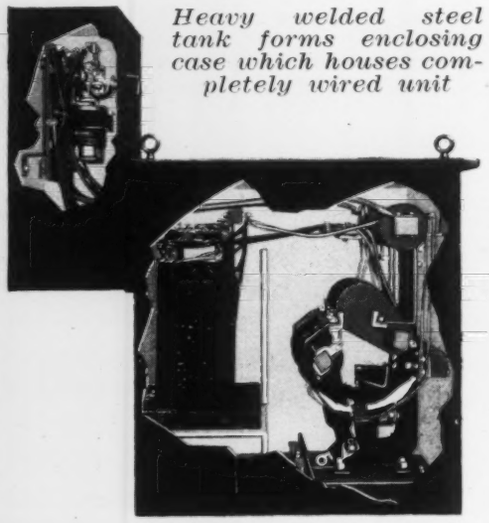
Manufacturers of Drafting and Surveying Supplies

complete with overload relays and a self-contained potential transformer to secure 220 volts for the control circuit, is intended for across-the-line starting of squirrel cage and synchronous motors and may also be used to control the primary of slip ring motors. The starter is built for reversing, non-reversing and plugging applications.

As shown in the accompanying illustration, the enclosing case is a heavy welded steel tank, which houses the completely wired unit. A longer tank containing two type ZHS magnetic contactors, mounted back to back and mechanically interlocked, is supplied for reversing, non-reversing and plugging applications. All live



Heavy welded steel tank forms enclosing case which houses completely wired unit

parts are totally enclosed and grounding the case provides a shockproof installation. Type ZHS full voltage magnetic starters are available in two sizes with maximum ratings of 600 horsepower and 1200 horsepower, respectively.

Tooth Form Provides Strength

A NEW gear tooth form placed on the market by Hammar Co. Inc., 17 State street, New York, and available through license, provides gears of maximum strength and minimum wear. The tooth form is so designed as to give the most efficient distribution of metal, the tooth contour lying close to the inscribed parabola of uniform strength. Reducing the excess metal at the top of the tooth allows a mating tooth with a wide base. Pinions have teeth which are always wider at the root than at any other point even with low tooth numbers.

Tooth contours have large radii of curvature and will withstand greater compressive loads. Contact starts well outside of the base circle; slip is held within finite limits and pitting and wear materially reduced. The system has been standardized so that it can be used in place of any of the common systems and with the same formulas. Tooth form can be cut on

Twelve tooth pinion teeth showing excess metal outside parabola of uniform strength

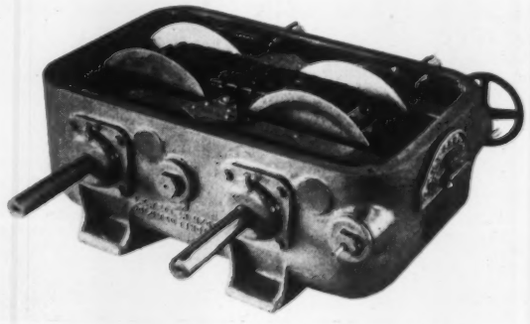
any standard gear cutting machine and is adaptable to spur, helical and herringbone gearing.

Unit Employs Pressure Lubrication

EQUIPPED with ball bearings and totally enclosed, a new variable speed transmission designated as the "100 series" has been announced by Lewellen Mfg. Co., Columbus, Ind. The interior of the mechanism follows the principle of operation of the present transmission, but the new series is a departure from other drives in several respects.

With the enclosure water and dust tight, protection is adequate for moist and abrasive conditions. Access to the interior is had by removing the cover of the unit. Pressure lubrication throughout is another feature and still another is the compactness of the unit.

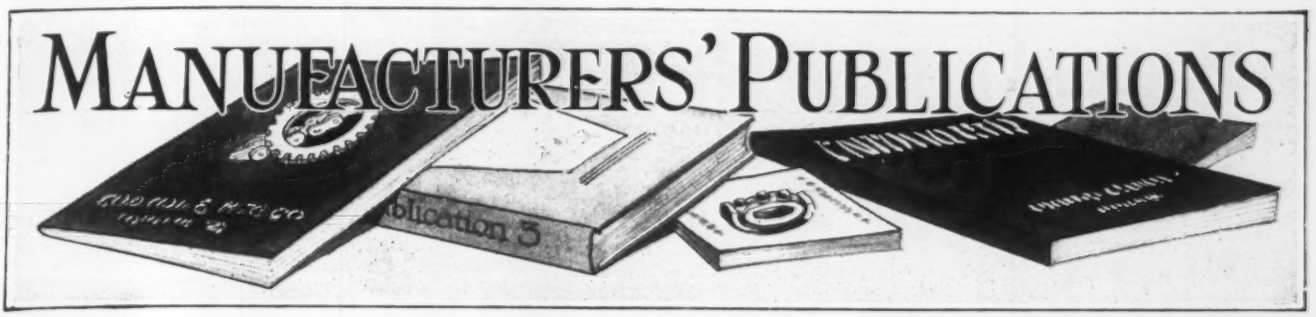
Accident hazard is eliminated while increase in power along with reduced wear and tear on the mechanism is obtained. This new series is available with motor drive support, remote con-



Variable speed transmission with cover removed to show operating mechanism

trol and other appliances. It may be supplied in regular speed ranges and can be operated in either direction, mounted in any position, and either shaft may function as the variable or constant speed member.

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained without charge from the manufacturers of the products or through MACHINE DESIGN

GEARS—Catalog No. 49 recently was issued by Boston Gear Works Sales Co., North Quincy, Mass. It contains additional data on new products including spur gears, change gears, non-metallic gears, worm gears, chain, chain drives, speed reducers, jack couplings, sleeve couplings, collars and ball bearings.

MOTORS—Bodine Electric Co., Chicago, recently issued a bulletin No. 1002-B containing data on its series intermittent motors with and without speed reducers. Illustrations supplement the text which goes into detail regarding the construction of the units. Ratings, catalogue numbers and dimensions are given.

CORK—"Industrial Applications of Cork," is the title of a 48-page booklet recently issued by Armstrong Cork Co., Lancaster, Pa. The subjects have been grouped and indicate the extent to which cork now is serving industry in finished products and processes. It is interestingly illustrated.

ACID STEEL PRODUCTS—Heppenstall Co., Pittsburgh, has issued a booklet describing its materials for the steel industry, automotive, electrical refining and other branches. The booklet describes its metallurgical service and products, including acid open-hearth steel, die blocks, shear knives, forgings, electric induction steel and alloy steels.

LUBRICATION—Bowen Products Corp., Auburn, N. Y., recently issued a 16-page catalog describing its industrial lubricating systems. Illustrations show design of equipment and a parts list of the Type B system is given. The last page contains general information.

POWER TRANSMISSION—Worthington Pump & Machinery Corp., Harrison, N. J., has issued a bulletin describing its belts of multiple strands of V-shape and grooved pulleys to match the strands. Illustrations show their application.

DRAFTING ROOM EQUIPMENT—C. F. Pease Co., Chicago, recently placed in distribution Catalog M-29 covering its line of blue printing machinery, blue print paper, and drafting room furniture. The booklet contains 100 pages, is indexed and supplemented by a price list. Illustrations are shown throughout the text.

ELECTRICAL PRODUCTS—General Electric Co., Schenectady, N. Y., has just issued its biennial general catalog. This supersedes all previous catalogs except those relating to railway, mine and industrial supplies. It contains 1146 pages and is fully illustrated. It is thumb-indexed in 16 sections, including generation, wire and cable, distribution transformers, arrestors and capacitors, voltage regulators, switching equipment, switchgear, meters and instruments, lighting equipment, motors, motor applications, industrial control, transportation, industrial heating, miscellaneous and indexes.

FLEXIBLE METAL HOSE—American Metal Hose Co., Waterbury, Conn., recently issued a 32-page booklet on its products which include flexible metal hose, flexible metal tubing, flexible metal conduit and seamless flexible tubing. Uses of flexible metal hose are listed and a comprehensive description given. Illustrations are used profusely throughout to show the many and varied applications.

SPEED REDUCERS—A leaflet describing two of its speed reducers has been issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. They are built with single helical gears, antifriction bearings and splash lubrication, as well as equipped for single and double reduction. Data are included covering horsepower ratings, speeds, dimensions and weights, accompanied by outline drawings.

BRONZE ALLOY—Bridgeport Brass Co., Bridgeport, Conn., has issued a booklet on duronze, a silicon bronze the company has developed for uses where high strength is desired, giving qualities not possible with brass. The booklet describes the alloy and illustrations show uses to which it is being put.

ELECTRIC MOTORS—Fuerst-Friedman Co., Cleveland, has issued a bulletin describing its electric motors manufactured by the Diehl Mfg. Co., the electrical division of the Singer Mfg. Co., for which it has recently taken over sales. Illustrations show construction and general design of the motors.

INGOT IRON—American Rolling Mill Co., Middletown, O., pressing its campaign to broaden use of its product, has issued two leaflets, one dealing with use of its sheets for refrigerator cars and the other for locomotive jacket sheets. Each is illustrated and contains data of interest for builders of these classes of railroad equipment.

BEARINGS—Timken Roller Bearing Co., Canton, O., has published a 16-page booklet under the title, "Timken Bearings in Rubber Mill Equipment." It gives the latest information covering mounting practices and general data concerning application of tapered roller bearings to practically every sort of machine used in the industry. The text matter is divided into five sections, each being illustrated with sectional views showing details of the bearing mountings.

BOLTS AND NUTS—Dardelet Threadlock Corp., 120 Broadway, New York, has issued a booklet on its nuts and bolts with special thread. The type of thread and its locking action are described and illustrated. Advantages and economics of the new form of thread are summed up.

RARE METALS AND ALLOYS

TANTALUM · TUNGSTEN · MOLYBDENUM · CAESIUM · RUBIDIUM

FANSTEEL
for
Contact Points

Laboratory Control . .
over every step in every process

To make contact points perform better and last longer, Fansteel invented the process of sawing contact discs from rods, presenting *end grain* metal as a contact surface. To guard against impurities in metal or imperfections in manufacture, every step in every process is under constant laboratory control. Each tiny contact point is inspected several times.

Fansteel carries at all times a large stock of standard sizes and types of Tungsten Contacts, or will design points and fixtures especially for your product. The major part of all contacts used today are supplied by Fansteel or made under their patents. Go direct to Fansteel for recommendations and quotations.

OTHER PRODUCTS

[— Molybdenum — *for high temperature furnaces*]

Temperatures up to 2000 C.—far beyond the melting point of ordinary resistance wire—are possible in furnaces wound with Fansteel Molybdenum wire. You can easily make these furnaces yourselves, or we will put you in touch with reliable manufacturers. Consult Fansteel on all rare metal needs.

FANSTEEL PRODUCTS COMPANY, Inc.
NORTH CHICAGO, ILLINOIS

MEN OF MACHINES

(*Concluded from Page* 60)

ing instructing in machine and internal combustion engine design. He was later appointed professor of machine design in charge of the design and testing of motor cars, engines and parts thereof, as well as the heat treatment of metals. He remained at the university until 1917, and during the World war was commissioned as major in ordnance. In 1926 he was made research manager of the society.

* * *

C. H. Dengler, until recently chief engineer of the New Way Motor Co., of Lansing, Mich., is now a designing engineer with the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa.

* * *

Ernest Dickey, until recently chief engineer for the Delco Light Co., of Dayton, Ohio, now is research engineer with the North East Appliance Corp., of Rochester, N.Y.

* * *

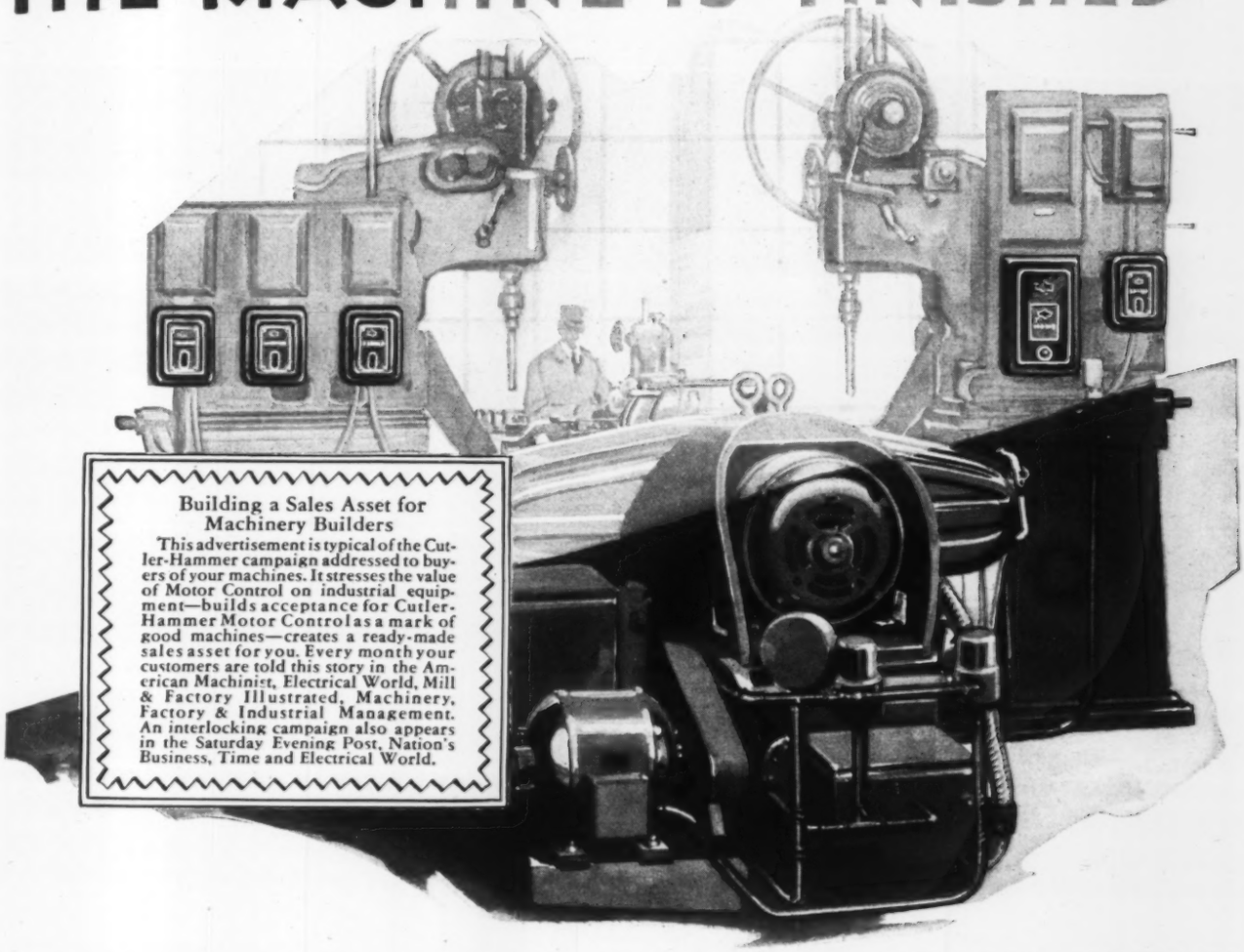
Charles D. McCall has joined the staff of Manning, Maxwell & Moore Inc., New York, and has been appointed manager of sales for Putnam machine tools in the Detroit territory with headquarters in the General Motors building. He formerly was chief engineer of the Jefferson division of the Chrysler Corp.

Obituary

GLENN H. CURTISS, pioneer in aviation, died July 23 in a Buffalo hospital following an operation for appendicitis on July 11. He was born in Hammondsport, N. Y., May 21, 1878. When he was 14 years old the family moved to Rochester where he became employed by the Eastman Kodak Co. Later he engaged in building and driving racing automobiles and was considered a youthful mechanical genius. By 1902 he had set up his own motorcycle factory and in 1907 he was invited by Dr. Alexander Graham Bell to become director of experiments for the Aerial Equipment association. The first flight of the machine produced by Curtiss and Bell took place the next year. Planning involved seven months, building seven weeks and eleven seconds after it left the ground, it crashed. Immediately following the ill-fated flight Curtiss built another ship which won him the *Scientific American* trophy for a sustained flight of one kilometer on July 4, 1908.

PROOF

THE MACHINE IS "FINISHED"



Building a Sales Asset for Machinery Builders

This advertisement is typical of the Cutler-Hammer campaign addressed to buyers of your machines. It stresses the value of Motor Control on industrial equipment—builds acceptance for Cutler-Hammer Motor Control as a mark of good machines—creates a ready-made sales asset for you. Every month your customers are told this story in the American Machinist, Electrical World, Mill & Factory Illustrated, Machinery, Factory & Industrial Management. An interlocking campaign also appears in the Saturday Evening Post, Nation's Business, Time and Electrical World.

A MOTOR-DRIVEN machine is "finished"—ready for today's production requirements, only when the motor is protected against all emergencies . . . only when it is both safe and convenient to operate . . . only when maximum production per day, per month, per year is assured by modern Motor Control.

The Cutler-Hammer trade-mark on the Motor Control of a motor-driven machine is proof the builder has finished his job . . . that he has done his conscientious best to meet your production requirements regardless of cost. It is proof he knows the value not only of protecting motors but of protecting them accurately.

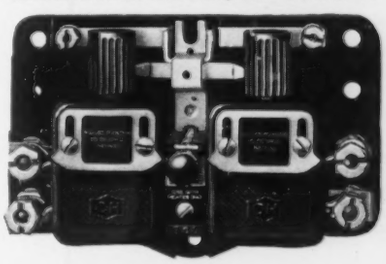
Use the Cutler-Hammer trade-mark on the Motor Control as a guide in selecting motor-driven machines. Use it for motors purchased separately; it is recommended by motor builders to guarantee satisfactory service to you and it is stocked by reliable electrical wholesalers in all important centers.

CUTLER-HAMMER, Inc.
Pioneer Manufacturers of Electric Control Apparatus
1310 St. Paul Avenue
MILWAUKEE, WISCONSIN

MORE USABLE H. P.

The Cutler-Hammer Thermal Overload Relay protects motors so accurately against overloads that heavier loads are handled with safety. And its accuracy is permanent.

Nothing to replace after tripping . . . just press reset button to put motor back in service. It is used on the entire C-H Standard Line of Automatic Starters.



CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

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